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EDDY CURRENT LOSSES IN DYNAMO ARMATURES.

On another page of this issue is given an abstract of a valuable paper presented recently by Mr. B. M. Field on so-called idle currents. The part of the paper which is of the greatest interest is that which gives a method of computing the losses due to eddy currents in embedded conductors. It used to be held—in fact, the statement can yet be found in the text-books—that embedding a conductor in a slot in the armature core does away with eddy current losses in it, it being said that the flux slips across the slot quickly, leaving no time for such currents to be developed. This idea is now known to be false, as it has been shown experimentally that such losses do occur, and under certain conditions they may become important.

Every conductor through which a current is passed sets up around it a magnetic field. If the current be alternating this field will also alternate, and therefore give rise to secondary or eddy currents in neighboring conducting bodies. If there be but one conductor in the deep slot the intensity of this alternating field will be very different in the inner and outer layers of the conductor, and there will therefore be parasitic or eddy currents set up in the conductor itself. The method of computing these currents and the deductions which can be drawn from the computation are interesting and significant. It might be well to call attention here to the fact shown by Mr. W. M. Thornton in his paper which appeared in the ELECTRICAL REVIEW for April 7 that the magnetic flux due to the field passes across the armature slots, and thus may also exert some effect upon eddy currents in the conductors.

The most significant deductions drawn from Mr. Field's investigations are that there is a certain depth of conductor which gives rise to the minimum loss in the armature copper. Of course, the straight copper loss due to the main armature current will decrease with the increasing cross-section of the conductor. On the other hand, the eddy current losses increase with the cross-section. The curve representing the total loss, which is the resultant of these two losses, would therefore show a minimum for a certain depth of conductor, and this value is independent of the armature current. It is also shown that the same effect takes place, but to a different degree, if the armature conductor be split up into a number of parallel bars. The loss might, of course, be reduced considerably by employing stranded wires, but this would add much to the cost of construction.

Another interesting point brought out in the paper is that an increase in the temperature of the armature conductor, while it will increase, of course, the copper loss due to the main armature current, will decrease the eddy currents and therefore the eddy current losses, and the result may be a decrease in the total loss and therefore an increase in efficiency. An increase in efficiency with rising temperature seems paradoxical, but the argument, of course, is sound.

The paper referred to above deals mainly with the losses due to eddy currents in the armature conductors. To make the reference to the subject complete, attention should be called to the able paper presented at the Asheville convention of the American Institute of Electrical Engineers by Mr. A. B. Field, in which an analytical study of eddy currents was made and the effects of stranding shown.

MEASURED TELEPHONE SERVICE.

Our esteemed contemporary, the Chicago *Tribune*, does not agree with us that the most equitable way of charging for a telephone is by the so-called measured service. It says that the Chicago telephone users who prefer the flat rate ought not to have a service which they do not desire forced upon them. "There should be freedom of choice in this matter. If a man would rather pay a fixed sum per year than let the size of his telephone bills be determined by the number of calls—he being obliged to take the company's unmetered word as to the number—should be free to do so. There may be men who prefer a certain to an uncertain charge, and like to use their telephones as often as they please without the unpleasant feeling that they are thereby adding to their expenses. Nobody disputes the right of the user to have measured service if it suits him best. The same freedom of choice should be granted to those who wish the other kind of service." Will our contemporary allow us to extend this argument to another public service—the city railway system, so that those who prefer may pay a fixed charge for transportation during the year and ride as much as they please?

The intimation that a measured service is unmetered is not strictly in accordance with the facts. Measured telephone service is metered. In New York city meters have been in use for ten years or more. Here they record with accuracy calls made from nearly 200,000 telephones. These meters are operated to record only completed connections. They register in plain figures and may be inspected at any time by subscribers.

If heavy users of the telephone may reduce the cost of paying a fixed annual sum for unlimited service, the cost of rendering the service makes it necessary to charge a higher message rate to those who take the measured rates than would be necessary if all the service were metered. Those who would profit by the lower measured rates are the small users, and they outnumber the heavy users by ten to one. If a flat rate be made optional to heavy users it must be at the expense of the ninety-odd per cent of the small users.

But there is another phase of the question which has not been touched upon. Nothing so congests and impairs telephone service in a large exchange as a flat-rate method of charging used by business houses. The idea that the telephone is free makes it free for all. It is used by office boys, clerks, visitors and every one, often for useless and unwarranted purposes, throughout every business day. The result is that such lines are very frequently busy when called for. The growth of an exchange aggravates this trouble, and judging from the reports of the Chicago telephone engineers, the service in that city is more impaired by means of these overloaded flat-rate lines than from all other causes combined.

So we must repeat that those subscribers in Chicago who demand a flat-rate service are standing in their own light, and they are making themselves responsible for poor service which no telephone company can control. The experience in many large telephone exchanges throughout the world has shown this to be true.

ELECTRIC HOISTING IN A MINE.

On another page of this issue is described briefly the first electric hoisting plant installed in Great Britain for use in a mine. This is the winding plant adopted by the Tarbrax Oil Company for the Cobbinshaw pit, a mine about fifteen miles from Edinburgh. Although the mine is not deep, being only about 140 yards, and the output is not very great, amounting to some 650 tons in a day of eight hours, the installation is noteworthy because it is the first attempt to adopt the motor for mine hoisting in Great Britain. On the Continent of Europe there are a number of mines where the electric motor is employed for hoisting. Elsewhere the system has been viewed with some suspicion, and mine operators hesitated to adopt it, preferring to depend upon the old steam-hoisting gear. For this reason the performance of this Scotch equipment will be watched with much interest, and if it comes up to the satisfactory reports which have up to this time been given out, it is probable that the system will be considered more favorably and possibly be pretty generally adopted. This is more likely to be the case in Great Britain now that electric power is being used so widely for mine work there. In fact, the plans which are being developed throughout the coal district of the country will almost force the adoption of the electric motor. In these sections large electric generating plants are being erected for the purpose of distributing power to the various mines and industrial establishments within easy transmission range.

The main difficulty in applying the electric motor to hoisting work of this character is the excessive output required of the motor during the first few seconds at the beginning of the hoist, when the motor is not only required to lift the dead load, but must accelerate it. During this brief period the output may be several times that of the normal load during the rest of the hoist. Such irregular loading not only interferes with the regulation of the generating plant, but it calls for a plant considerably larger than that required for the average load. For these reasons the operation of the plant is likely to be inefficient, the load-factor being poor. For a successful application of the electric motor it is necessary to overcome this objection, which has been done by means of the so-called Ilgner system, used to a considerable extent in Germany and Austria, and adopted for this Scotch mine.

In the Ilgner system the varying load on the generating station is balanced by means of a heavy flywheel. In the particular system under consideration the power is brought to the head works by means of a three-phase, low-voltage line, and is there used to drive an induction motor. This motor is directly connected to a direct-current generator, which supplies the power for the hoisting motor. On the shaft of the motor-generator is placed a heavy flywheel, which absorbs the excess power during idle periods to give it out when the winding motor is accelerating. This arrangement, of course, does not remove any strain from the winding motor, but since the latter machine runs at a low speed and must anyhow be large, there is no difficulty in

constructing it to stand a considerable overload for a short period.

This, in main, is the principle of the Ilgner system, but for it to be applied successfully necessitates that the flywheel be effective in absorbing energy during the periods of light load and in giving it out during heavy loads. As is well known an induction motor is essentially a constant-speed machine. The variation in speed of large motors of efficient design from no load to full load is seldom more than two per cent, and this slight variation is not sufficient to enable the flywheel to give up any considerable portion of its stored energy. It would therefore be necessary to use an excessively heavy wheel if other means were not provided for overcoming the difficulty. At the Cobbinshaw pit this is done in a very pretty manner. The speed of the induction motor is caused to vary with the load by automatically inserting resistance in the rotor winding. The amount of resistance thrown in is proportional to the load on the generator, so that the speed falls off to a corresponding degree, and the flywheel automatically gives out or absorbs, as the case may be, the excess energy required from, or supplied to, the system. Since the periods of heavy load are brief, the effect of this system of regulation on the efficiency of the plant is slight.

It is interesting to note here that flywheels which are frequently called for in order to steady the load on a generating plant when the work required of any motor is of a varying character are frequently prescribed merely by rule of thumb. No consideration is taken of the type of motor employed, it being thought that the mere addition of a heavy wheel is all that is necessary. This is incorrect, as is illustrated by the Cobbinshaw plant, for if a constant-speed motor be used for this purpose the flywheel is of little benefit. An induction motor or a plain shunt motor is therefore not suitable for such applications unless means are provided for bringing about a variation in speed with load which will allow the flywheel to become effective. Where induction motors are used either a rotor having a high resistance must be employed or some such means as that referred to above must be adopted. Where the service is by direct current it would seem advisable to employ a compound motor, the series windings being arranged so as to cause a proper decrease in the speed with an increase in the load.

The method of introducing the resistance in the rotor circuit of the winding motor referred to above is neat and would seem to be applicable in other processes. The mechanism performing this function resembles an induction motor, except that the rotor is not allowed to rotate, but merely to turn in one direction or the other, this turning introducing or cutting out the resistance in the rotor circuit of the main driving motor. The alternating currents supplied to this motor are passed through the stator windings of the regulating machine. They therefore set up a torque which is proportional to the load on the main motor. This torque is opposed by a counterweight which normally short-circuits the rotor resistance. As the load comes on the rotating part turns through an angle, depending upon the amount of load, and decreases the speed at which the main motor would run were it not for the flywheel, and therefore allows the flywheel to give up its stored energy. A neat feature of the Ilgner system is the ability to return power to the flywheel during the descent of the hoisting cage, in this way saving energy that would otherwise be lost in braking.

AN OCCULT USE OF THE TELEPHONE.

Of course it occurs in Boston, the home of the transcendental movement, that a young lady in the cashier's cage of the furnishing goods store stands ready to make reply over the telephone stating without delay the playing card which an unseen subscriber had drawn, or is fixing his mind firmly upon.

All that one is required to do is to select the card and look up the number of the firm in the book and call for this lady through the private branch exchange and the immediate reply is suggestive to an uncanny extent of the supernaturalism of the Mahatamas.

It brings up remembrances of the miraculous tales of East India fakirs as related by Marion Crawford in his weird book, "Mr. Isaacs"; or the later day stories of how the fall of Khartum and the tragic death of Chinese Gordon were related among the bazaars of Cairo on the day following the tragedy, while it required weeks for the forces of the British army to ascertain the facts and relieve the intense suspense of the civilized world over an event which overthrew a British ministry and changed the course of history.

One's mind is torn from this trend by the sudden reminder of a dinner or other wager depending upon this accurate card reading through the telephone; and on another page of this issue we present the method by which this can be done through any telephone exchange.

NEW FIRE-ALARM SYSTEM NEEDED IN NEW YORK CITY.

In our issue of October 14, 1905, an abstract was given of the excellent and convincing report made by Mr. Kempster B. Miller regarding the dangerous condition of the fire-alarm system in the Borough of Manhattan, New York city. Mr. Miller was retained as the electrical engineer by the New York Board of Fire Underwriters to investigate the New York fire-alarm system and report upon it. The work required some months and was done most thoroughly, and the conclusions were entirely approved by Mr. John J. Carty, who was acting as consulting engineer. In brief, the report stated that the Manhattan fire-alarm system was in a very dangerous condition and that there was the greatest need for an entirely new system, which would cost about $1,625,000.

On another page of this issue we present a copy of a recent letter sent to Mayor McClellan, of New York city, by Mr. J. H. O'Brien, commissioner of the New York city fire department, in which the commissioner asks that $1,625,000 be appropriated for the purpose of constructing the much-needed fire-alarm system. It is to be hoped that the Board of Estimate and Apportionment will see fit to grant this request, so that the Borough of Manhattan may be exposed to the danger of a complete failure of the present system only so long as is necessary to install a modern reliable one.

Interior Illumination.

At a meeting of the Illuminating Engineering Society, held at the Edison auditorium, New York city, Thursday evening, April 12, two papers were presented on the general subject of interior illumination. The first of these was by Mr. Douglass Burnett, of Baltimore, Md., and in the absence of the author it was read by Dr. Clayton H. Sharp.

Mr. Burnett's paper was a plea for the establishment of a code which could be used in drawing up schemes for lighting buildings or streets. At the present time there seem to be no rules for guiding anyone to whom such a duty falls. On the other hand, it is perfectly possible to draw up a set of rules which would be of great service to every one confronted with such a problem, and in the author's opinion this duty could very properly be undertaken by the society.

Mr. Burnett then presented, in the form of questions, a number of problems which come up in every-day practice. These included the problems involved in lighting show windows, lighting department stores, drug stores, jewelry stores and other buildings. The question was raised whether the trough reflector is not better than border lamps for window illumination, and also the value of the trough reflector as compared with the conical reflector. Should an arc lamp placed in the vestibule be depended upon for lighting the window? Should not the lighting of drug stores, which are generally small buildings, be by means of incandescent lamps? In department stores should not there be two types of lighting—a white light where day goods are sold, and a yellow light where goods to be used during the night are shown? Do arc lamps give the most effective lighting in jewelry stores, or would a better effect be produced by a greater number of lower-power lamps?

The question was also raised regarding the relative value of chandeliers and large units of light in stores. It is said that it is impossible to predict which type of lighting will give the best effect. If arc lamps are adopted, in any case should there not be a general rule giving the maximum distance from the floor to the lamp? Often when lamps are installed it is found that they are improperly placed. In department stores where large units are used they should be placed over the aisles and generally at the intersection of aisles. In this way the light comes from above and behind the customer, but this rule does not always hold. The question was raised also as to the best method of lighting an office. How could the most effective lighting of a desk be accomplished? The desirability of securing cooperation between the lighting company, the architect and the contractor who installs the lamps was emphasized.

The second paper was by Mr. R. M. Searle, of Mount Vernon, N. Y. The author first laid stress upon the necessity of a cordial understanding between the gas and electric lighting interests. They should work together and with the architects and wiring contractors, and all endeavor to educate the public in the subject of illumination. Mr. Searle then pointed out that in general about sixty per cent of the profitable income of a lighting company comes from consumers of moderate means. For this reason it is very important that the most effective use of the illuminants should be made, and no pains spared to improve the lighting of such customers. Attention was called to the effect of the decorations of a room upon the illumination. Where the walls surrounding are dark the effect will be gloomy, no matter how much light be introduced. On the other hand, with a light wall and ceiling one lamp will generally give a satisfactory and pleasing effect. Frequently the decorations in the room are changed without any modification being made in the scheme of lighting. Where the change is from light walls to dark the result is, of course, gloomy and unsatisfactory. On the other hand, if the change be made in the reverse way the excessive amount of light resulting fatigues the eye and produces discomfort and a general feeling of unsatisfactory illumination. In general it is advisable to provide more side lamps and fewer centre lamps. It is well to remember that the most profitable lamp—that is to say, the one which burns the longest—is the reading lamp, and this should always be provided for.

The discussion was opened by Mr. V. R. Lansingh, who agreed on many points with Mr. Burnett, but differed with him on others. Window lamps are generally employed to display goods, though sometimes they are used to attract notice. Usually, however, a store does not attempt to advertise the lighting company. It is essential in window lighting to hide all the lamps. This precludes border lamps, unless they be carefully shaded. It is always necessary to keep light out of the eye. Arc lamps in all cases must be placed high and reflectors used to throw the light down. Trough reflectors are not as efficient as cone reflectors, since some light escapes along the ends of the reflector. It is always advisable to use incandescent lamps for lighting a window in preference to an arc lamp placed in the doorway.

Regarding the illumination of jewelry stores, an example of a fine establishment of this kind in Salt Lake City was mentioned, in which arc lamps are employed with good effect. These lamps may be of particular value because of the blue rays which they give out. These give the diamonds a beautiful tint.

For office and desk lighting the direction in which the light comes should be carefully studied. Frequently the lighting of a desk is too intense. A case was mentioned in the office of Marshall Field & Company, Chicago, Ill., which is probably the finest store in the world. The chief engineer of this company said that since he has been with the company the amount of light in the bookkeeping department has been increased five times. The result is that all of the bookkeepers, with the exception of one or two new men, are wearing glasses. Their eyes have all been injured by the too intense illumination. A good deal of this effect is due to direct reflection of the light from the paper into the eyes. Regarding the lighting of theatres Mr. Lansingh agreed with Mr. Burnett that all the lamps should be hidden and no glare should be allowed to reach the audience. For lighting stores the practice may vary, as some of the best-lighted stores do not use arc lamps. It would be good practice, however, to provide several rooms lighted by different types of lamp, so that customers could take their goods to these different rooms and compare them under the conditions under which they would be used.

Dr. A. H. Elliott agreed in general with what had been said before. He also emphasized the tendency to use an excessive number of lamps, with a very bad effect. He mentioned one case where the dining-room of a house was lighted with gas lamps burning about sixty cubic feet an hour, and yet the effect was very bad. At his suggestion the lighting was rearranged, cutting down very greatly the amount of gas used, at the same time producing a far more satisfactory result.

Dr. Elliott then called attention to the recent German studies on the fatigue of the eye. These investigations, it is said, have shown the so-called visual purple in the eye—a substance which is destroyed by light. If the amount of light which reaches the eye is sufficient to destroy the visual purple at a rate greater than the eye can normally repair it, fatigue must result, and eventually injury. It is to be hoped that this investigation will be pushed further, because the results

would undoubtedly be of the very greatest value.

Mr. W. S. Kellogg also spoke of the undesirability of an excessive amount of illumination, and even the bad results obtained. Where bright points are in view, blinding of the eye results and leads to the belief that the lighting is poor. He cited a case in which the amount of light employed in a room had been reduced to one-third, with a much improved result.

Mr. Thomas J. Lytle cautioned the society against the use of the Welsbach mantles which give a green light. The Welsbach company now furnishes mantles which give a mellow white light, and it is gradually educating the public to use these. It is strange that the general opinion is that the mantle giving a green light is the more efficient, while as a matter of fact more light is given out by the yellow filament. Mr. Lytle also emphasized the need of taking into account the color scheme of a room when planning for its lighting. The practice of using dark-colored walls and ceilings is bad and should be discontinued. He has been experimenting during the past winter in this matter and has found that a slightly tinted globe with light walls and slightly tinted ceiling gives excellent results. In such a room one lamp gives all the light that is needed. It is stated that the Welsbach company has found that the inverted mantle is a very efficient source of light. The question of securing a proper distribution of light is to-day becoming more and more one of selecting a properly shaped globe or reflector.

Mr. J. D. Israel said that one question which had not yet come up was that of mixing lamps. This, of course, must be carefully guarded against. Generally the illumination of large stores is best secured by large lighting units. He mentioned a case where a number of girls were employed in a large room on detail work. For such a condition it would generally be assumed that a small lamp provided for each girl would give the best result, but it was found that there was less strain and better work could be accomplished where large lamps were used. Mr. Israel said that some years ago the Philadelphia Electric Company, with which he is connected, had established a commercial inspection department for the purpose of securing cooperation between consumers, the fixture people and the company; that this department held meetings, at which the matters pertaining to the subject of lighting stores and homes were discussed, and accomplished excellent results. It had been found that the consumers appreciated the efforts of the company in this direction.

Mr. John Campbell called attention to the bad effect produced when competing salesmen make exaggerated statements respecting their goods. Heretofore the rule of thumb has been used entirely too much in planning illumination. More scientific methods are needed, and it is essential that the public be educated in the matter.

Mr. T. R. Beal said that gas must still be considered the main illuminating agent, and particular attention must be paid to the way in which this is employed. For this reason these companies have exceptional opportunities for advising customers. They should be instructed in the proper use of gas and cautioned against inefficient burners, which consume an excessive amount of gas.

Mr. A. D. Page criticized the present style of fixtures. These are bad and are generally nothing more than a mass of brass and glass, nine-tenths of which is unnecessary. The fixture man should be required to change the construction, to cut out the unnecessary material and furnish a satisfactory support for the lamps.

Mr. Kellogg agreed with this, but said that the plan could not be carried out easily, because the fixture man will insist on his outlines. The lamp or reflector man must therefore do the best he can with what is given him.

Mr. W. D'A. Ryan said that people are now used to a strong light and will not be content with less. In the lighting of large stores the lower floors, where day goods are shown, should be lighted with white light. Elsewhere, in the hardware and furniture departments, a yellow light is entirely satisfactory. For a jewelry store white light is good, but if the light come from many points a brilliant effect is produced. An art museum presents one of the hardest problems, for not only must the light be thrown in the proper way, but the same quality of light must be obtained as that by which the picture was painted. In general, it may be said that in department stores the lighting should be half and half, with a preference for the white light.

Mr. Searle returned to the point of eye fatigue. He mentioned a case where an excessive amount of light at night had rendered literary work almost impossible. In this case the amount of light had been reduced to a small part of that previously used, with the result of removing the strain and overcoming the fatigue.

Mr. E. L. Elliott, replying to Mr. Kellogg, said that a fixture is primarily a mechanical device for holding lamps. It should, therefore, be, first, a device for this purpose, and, secondly, decorative. The idea of taking a decoration and making it useful is wrong; therefore the fixture man should be forced to produce a satisfactory mechanical device, and then he may be allowed to give this such twists and curves as are most pleasing to his fancy.

The New Holland-America Liner New Amsterdam.

The Holland-America Line's new steamship, the New Amsterdam, sailed from Rotterdam on April 7 on her maiden transatlantic voyage, arriving in New York on Monday, April 16. The ship was built by Messrs. Harland & Wolff, Limited, at Belfast, Ireland, and was launched September 28, 1905. Her length is 615 feet; beam, sixty-eight and one-half feet; depth, forty-eight feet. Her registered tonnage is 17,250 and her displacement is 30,200 tons. She is propelled by twin screws, and these are driven by two separate sets of quadruple expansion engines of 10,000 horse-power, each set working independent of the other.

The hull is constructed entirely of steel, with a double bottom extending the whole length of the ship. Twelve transverse bulkheads reach to the upper deck, dividing the ship into thirteen water-tight compartments. In addition there is a water-tight bulkhead separating the two sets of boilers.

The ship is lighted throughout by electricity, which is also utilized for heating purposes in several of the public rooms. Four large dynamos are installed for this work.

The decorative features of the interior of the steamship are elaborate, and every effort has been made to afford comfort as well as luxury. A feature of the first-class smoking-room is the Dutch decoration, the fire-place being equipped with an electric heating apparatus.

Ample protection against fire is provided by the installation of electric signals with more than fifty stations in various parts of the ship and by the adoption of the most modern and efficient systems for preventing fires at sea.

The ship is equipped with a double Marconi wireless telegraph service for both short and long-distance use.

On the evening of Wednesday, April 18, a banquet was tendered to a number of prominent New York public men, on board the ship. Speeches were made and a generally enjoyable evening spent, an inspection of the ship being made under the guidance of the officers and aides.

A Preliminary International Electrical Conference.

A preliminary conference on electrical units was held at Charlottenburg, Germany, October 23, 24 and 25, 1905. Those in attendance were Dr. H. S. Carhart, for the United States of America; M. Éric Gerard and P. Clément, for Belgium; Dr. Th. Lewald, Professor F. Kohlrausch, Professor E. Warburg, Professor E. Hagen, Professor W. Jaeger and Professor St. Lindeck, for Germany; Dr. R. T. Glazebrook, for England; M. E. Mascart, for France; Herr V. v. Lang and Dr. L. Kusminsky, for Austria. A number of sittings were held, and the following formal decisions were reached:

1. That only two electrical units shall be chosen as fundamental units.

2. The international ohm defined by the resistance of a column of mercury and the international ampere defined by the deposition of silver are to be taken as the fundamental electrical units.

3. The international volt is that electromotive force which produces an electric current of one international ampere in a conductor whose resistance is one international ohm.

4. The Weston cadmium cell shall be adopted as the standard cell.

The conference recommends the following procedure for the realization of the ohm:

1. The method which avoids the end correction should not be employed.

2. The Reichsanstalt will put itself in communication with Messrs. Schott & Company, of Jena, in order to determine whether glass tubes of sufficiently uniform section can be produced of the glass 59III.

3. The glass tubes used in setting up mercury resistances are to be carefully annealed.

4. The tubes are to be filled in vacuum without heating.

5. In determining the weight the mercury column is to be bounded by planes at the terminal cross-sections of the tube and to be at a temperature of zero degrees centigrade.

6. The length measurements are to be made as far as possible at zero degrees centigrade with the aid of contact pieces.

7. The electrical measurements are to be carried out at zero degrees centigrade and a method is to be employed which avoids the use of thick connecting wires. Among such methods the Kohlrausch differential galvanometer method, the Thomson double bridge method and eventually the compensation method are recommended. The current employed in measurement shall be limited by the condition that the mercury shall not be warmed sufficiently to produce appreciable error.

8. The mean of at least three fillings shall be taken as the value of the resistance of a tube.

9. The mean of at least five tubes must be taken to determine the value of the mercury unit.

10. The mercury standards shall have a resistance of approximately one ohm.

11. As the value of the wire standard the mean of at least five resistances of one ohm shall be taken.

12. A comparison of the wire standard with the mercury units shall be carried out at appropriate intervals of time.

The Weston standard cell shall contain solid hydrated cadmium sulphate; the strength of the cadmium amalgam shall be twelve to thirteen per cent of cadmium.

In the form of the normal element of the standard cell to be finally specified sources of disturbance at the negative pole are to be avoided.

The conference expressed the wish that an international convention should be summoned in order to arrive at agreement in the electric standards which are in use in the different countries.

The following resolution was further adopted:

In view of the fact that the laws of the different countries in relation to electrical units are not in complete agreement, the conference holds it desirable that an official conference should be summoned in the course of a year with the object of bringing about this agreement.

The conference further expresses the opinion:

1. That the information before it is not sufficient to enable it to propose any alteration in the formerly accepted value for the ampere.

2. That the information before it is not sufficient to enable it to lay down exact directions in respect to the silver voltameter and the standard cell.

3. That if a proposal for a change in the accepted value of the ampere is to be brought from any source before a formal congress to be held later, an agreement in writing on the point should be come to previously between the parties interested. If differences of opinion in the matter can not be removed, a new preliminary conference should be held.

The same procedure should be observed in regard to the specification for the silver voltameter and the standard cell, in the event of such specifications being submitted to a formal conference from any quarter.

Some suggestions from the National Bureau of Standards were furnished to the conference. These outlined the investigations that ought to be carried out in order to make it possible for an international congress to redefine the electrical units. A proposal was submitted for new legal definitions of the electrical units, which is intended to harmonize the two views now advocated regarding the definition of electrical units. One view is that the ohm, volt and ampere should be defined in terms of centimetre gramme second units, and that the concrete standards should be made to conform as nearly to these definitions as possible. The other view is that the legal definitions should be in terms of concrete standards, nothing being said about the centimetre gramme second units. This proposal was that the definitions should state that the units are intended to have certain values in the centimetre gramme second system but their actual legal values are defined by certain concrete standards. It was suggested that a special commission be appointed, consisting of not less than twenty-four members, to encourage investigation in the direction recommended, and that this commission should be authorized to call an international congress when these investigations warranted. It was suggested, further, that the two units to be defined should be the ohm and the volt. A discussion of the electrochemical equivalent of silver by Dr. K. E. Guthe was appended to the suggestions. The National Bureau of Standards prefers the cadmium cell to the present standard cell.

A paper was also presented to the conference by Dr. Henry S. Carhart, in which he discussed the relative advantages of adopting the ampere or the volt as the legal standard. Dr. Carhart is decidedly in favor of adopting the volt. He points out the difficulties and uncertainties involved in the adoption of the ampere, and holds that the adoption of the volt would considerably simplify matters and lighten the labor of standardization.

American Institute of Electrical Engineers.

The 206th meeting of the American Institute of Electrical Engineers will be held in the assembly room of the New York Edison Company, 44 West Twenty-seventh street, New York city, on Friday, April 27, at 8.15 P. M. The following papers will be presented and discussed:

1. "Standardizing Rubber-Covered Wires and Cables," by John Langan, Associate, New York.

2. "Comments on Present Underground Cable Practice," by Wallace S. Clark, Associate, Schenectady, N. Y.

"IDLE CURRENTS."[1]

BY M. B. FIELD.

The term "idle current" is defined as meaning "all currents which do not perform useful work and consume energy to the extent of their C^2R losses." This includes eddy currents.

The characteristic of every form of idle current here dealt with is that, while constituting a part of the total current flowing in the circuit, it may be considered, conventionally, as an altogether separate entity superposed upon the real useful current and be treated as such.

To illustrate this take the case of an alternate-current system where the power-factor is less than unity.

Let C_1 be the amplitude of the useful or power component, C_2 that of the idle component of the current. The main ammeter indicates, as we know, $\sqrt{(C_1^2+C_2^2)/2}$. If this current flow in a conductor of resistance r ohms, the time average value of the ohmic loss will be $(C_1^2+C_2^2)\frac{r}{2}$. Considering the power and idle components as separate entities, we obtain for the ohmic losses due to each $C_1^2r/2$ and $C_2^2r/2$ respectively, so that the sum of these losses is identical with the time average loss due to the actual total current flowing.

It will be scarcely necessary to point out that this is not generally true of any arbitrary subdivision of a current into component parts—*e. g.*, a current of ten amperes flowing through a conductor of one ohm resistance would represent an ohmic loss of 100 watts. Magnetically, this current would be equivalent to one of fifteen amperes flowing in the positive direction superposed upon one of five amperes flowing in the negative direction. The sum total of the ohmic losses of these components would, however, be $225 + 25 = 250$ watts. While, therefore, it is self-evident that a current may not be resolved into any arbitrary components, and these be treated from all points of view as separate entities, yet we may always treat the power and idle current components as if they existed independently of each other.

This very simple conception is of material assistance in the consideration of some problems; for example, a certain distribution of current in a system of conductors may be a very complex matter to deal with as a whole. If, however, we can show that the complex distribution is equivalent to a "natural" distribution superposed upon an idle current and we can isolate the cause of the idle current, we may be able to estimate its value, and hence arrive at the characteristics of the actual complex distribution.

After discussing briefly the idle currents due to the wave-shape, a poor power-factor and cross-currents, the author takes up what he calls "internal idle currents."

These may be classified broadly under two heads: (*a*) those whose magnitude is determined by the degree of excitation and which depend very slightly, if at all, upon the load; (*b*) those whose magnitude is determined by the load and which depend very slightly, if at all, upon the excitation of the machine. Both produce a disturbance of the natural current density in the conductors of the machine and increase the losses in consequence. The first class may be said to add a definite constant loss (for a given excitation) to whatever loss would be occasioned by the natural distribution of current density, while the second produce an additional loss proportional to the square of the working current, hence the actual loss may, in this case, be determined by simply assuming a virtual increase of the resistance of the circuit. The exact meaning of this will be better appreciated later, but as an example we may mention that the so-called skin effect in a solid conductor traversed by an alternating current is really due to an idle current proportional to the working current flowing, while the total loss due to idle and working currents may be determined by simply assuming the resistance of the conductor has been, by some means, increased. Again, the additional loss in the sheathing and cores of a cable are proportional to the working current, and the total loss may be estimated by assuming an increase of the resistance of the conductors. The coefficient by which the actual resistance must be multiplied to allow for the additional losses depends upon the frequency, specific resistance and dimensions of the conductor.

Large generators usually have two or more paths through the armature, and an uneven distribution of current between the various paths is equivalent to a uniform (or natural) distribution superposed upon a system of idle currents. Again, each path may be composed of two or more conductors, laminæ or strands in parallel, and an uneven distribution between them is equivalent to a natural distribution plus an idle current. Lastly, the distribution of current density in each individual strand may be far from uniform, so that here again we have an idle current superposed upon a natural distribution.

It sometimes occurs that one particular class of idle current may predominate to a totally unexpected extent, and in fact a cooler, cheaper and more efficient machine may be obtained by a decrease of the amount of copper therein. As an illustration, the following may be cited, though the reference is to a type of machine which is now practically obsolete—*viz.*, the ironless flat disc alternator.

In Fig. 1 two poles of such a machine are represented with a portion of the armature consisting of copper strip wound into flat coils. Each strip, as it passes

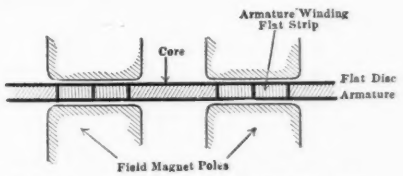


FIG. 1.—PORTION OF AN IRONLESS DISC ARMATURE.

edgewise through the magnetic field, has an idle current induced in it. To calculate the loss we may apply the eddy current formula used for iron armature plates and the like,[1] *viz.*:

Loss in watts per cubic centimetre $= f^2B^2t^2/6\times10^{15}\rho$; where t = thickness in centimetres; f = frequency, cycles per second; B = induction density in air-gap, lines per square centimetre; ρ = specific resistance in ohm-centimetres.

Let us take the nominal maximum current density at 310 amperes per square centimetre (= 2,000 amperes per square inch), then the nominal C^2R loss will be 0.18 watts per cubic centimetre at about forty-five degrees centigrade.

Applying the formula above, for the loss due to idle currents, we have for $f = 50$, $B = 5{,}000$, $\rho = 1.9 \times 10^{-6}$.

$t = 0.1$ cm. loss per cubic centimetre $= 0.0548$
$t = 0.2$ " " " " $= 0.22$
$t = 0.3$ " " " " $= 0.493$

and so on, hence, with an armature wound with strip two millimetres thick the additional loss due to disturbance of current density in the active part of the armature conductors is greater than the nominal C^2R loss. It is to be feared that this state of affairs exists in a considerable number of machines in use at the present time. The result of using thinner strip

[1] Abstract of a paper read before the Manchester local section of the Institution of Electrical Engineers of Great Britain, February 13

[1] This formula is applicable so long as the lines of force pass straight across the gap from pole to pole, the variation of induction being assumed to follow a sine law, and provided the thickness of the strip does not permit of idle currents of such magnitude as to sensibly disturb the distribution of magnetic lines, a contingency not likely to arise in the case under consideration.

might be to reduce the heating, and might increase the efficiency and provide a lighter and cheaper machine. For the same reason it is clear an increase of the specific resistance would cause a decrease of the total losses, hence we have the somewhat paradoxical condition that the efficiency improves as the temperature increases.

Our attention has been called to an interesting investigation published in Germany in 1903 by Dr. Simon Ottenstein, giving the results of tests made to determine, among other things, the "eddy current loss" in solid copper conductors laid in slots, due to the radial and tangential components of the flux within the slot, which emanates from the field magnets; this flux being quite independent of the load current in the armature conductors. The title of the investigation is "Das Nutenfeld in Zahmarmaturen und die Wirbelstromverluste in Massiven Armatur-Kupferleitern." The armatures experimented upon had a diameter of 225 millimetres, and the slots were dimensioned in

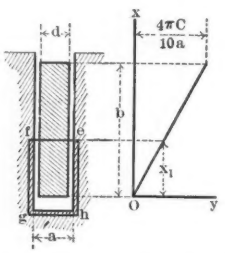


FIG. 2.—PATH OF MAGNETIC FLUX DUE TO CURRENT IN ARMATURE CONDUCTOR.

the different armatures as follows: 7 × 22.5, 7 × 35, 9 × 35.5, 7 × 23, 8.5 × 23, 14 × 11.75, the first dimension giving slot width and the second the depth in millimetres.

In the different experiments the theoretical tooth induction varied from 18,000 to 31,000, and the eddy current losses in the various solid conductors employed were found to be equivalent to the loss that would have been occasioned by a current density of from 400 amperes to 4,700 amperes per square inch in the active portion, depending upon size and position of conductor, dimensions of slot, air-gap and nature of polar surface. The frequency in all these experiments was 33.3.

The two previous examples cited are cases where the magnitude of the losses are dependent upon the degree of excitation and not upon the load on the machine, the following, however, represent the other case, where the losses are dependent upon the load current and not upon the degree of excitation.

In Fig. 2 we have represented a solid copper conductor of depth b centimetres and thickness d centimetres lying in a slot of a laminated armature. An alternating current flows in the conductor in a direction at right angles to the plane of the paper, the plane of lamination of the armature plates corresponding with that of the paper. We shall show that the current flows in layers, being densest in the outside layers at the mouth of the slot, and least dense at the root. For this reason we have thought that the term "lamellar effect" is not out of place in describing this phenomenon. It is, of course, closely allied to the skin effect in a circular conductor, where the idle currents flow in one direction along the peripheral portions and in the opposite direction along central portions.

The effect of any current flowing down the solid conductor in Fig. 2 will be to produce a magnetizing flux across the slot from side to side. If the width of the slot be small compared with the depth, the lines will be very nearly straight from wall to wall, except near the mouth of the slot, where they will bow outward.

If $efgh$ be a line of force, we know that the total magnetic force (or line integral) taken round the closed path will be $4\pi/10$ times the total current in amperes in that portion of the conductor enclosed within it. Now, the magnetic resistance of the iron portion of the path, *i. e.*, from e to h to g to f is negligible in comparison with the air portion from f to e, hence we may say with great accuracy that the line integral of magnetic force from f to e equals $4\pi/10$ times the current in amperes flowing in the conductor, between the limits $x = 0$ and $x = x_1$. The induction density at the mouth of the slot is, therefore, $\frac{4\pi}{10}\frac{C}{a}$, where C is the total current flowing in the conductor; and the induction at the slot root is zero. If, now, we suppose that the density of the cross induction increases uniformly from zero value at the root of the conductor to $\frac{4\pi}{10}\frac{C}{a}$ at the top edge, the total flux traversing the conductor will be $\frac{4\pi}{10}\frac{C}{a}\cdot\frac{b}{2}$ per centimetre length.

Consider a very thin lamina along the top edge of the conductor forming, in conjunction with a similar lamina along the lower edge, a loop through which this total flux threads. The electromotive force induced in this loop per centimetre length of conductor will be $\frac{4\pi^2}{10}\frac{bfC}{a}10^{-8}$ volts, where f is the frequency of alternation. This expression gives the root mean square value of volts, if C represents the root mean square value of the current. If the conductor be long in comparison with its cross-section, such an electromotive force would produce an idle current density flowing in the loop of value $\frac{2\pi^2}{10}\cdot\frac{bfC}{a\rho}10^{-8}$ where ρ is the specific resistance in ohm centimetres.

As an example we will write $f = 50$, $b = 5$-cm., $\frac{d}{a} = 0.7$, $\rho = 1.9 \times 10^{-6}$ (at forty-five degrees centigrade) when the value of the idle current density works out at about $2.6C/a$; but the nominal current density is $C/5d$; hence the idle-current density in the outer layers is over nine times the nominal current density when worked out on this basis, and the loss density (or loss per cubic centimetre) at

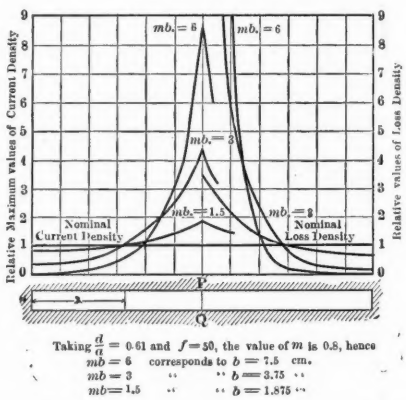

Relative Maximum values of Current Density
Relative values of Loss Density
mb = 6
mb = 6
mb = 3
mb = 1.5
mb = 1.5
Nominal Current Density
Nominal Loss Density
P
Q
Taking d/a = 0.61 and f = 50, the value of m is 0.8, hence
mb = 6 corresponds to b = 7.5 cm.
mb = 3 " " b = 3.75 "
mb = 1.5 " " b = 1.875 "

FIG. 3.—CURVES SHOWING DISTRIBUTION OF CURRENT AND LOSS DENSITY DUE TO TWO CONDUCTORS IN A CLOSED SLOT.

the extreme edge due to the idle current is over eighty times that due to the nominal current density.

This example has been cited to show in a rough and ready way that some phenomenon occurs in such conductors which is well worth while studying. The assumption made that the distribution of cross flux is that which would be given by a uniform current density is obviously disproved by the result of the calculation, and the actual redistribution of the cross flux is such as to materially reduce the estimated idle current effect. While, therefore, the above result is greatly exaggerated on account of the assumption made, it may be mentioned that machines are at work to-day where the loss density in the outer edge of the conductor is as much as thirty times that due to the nominal current density.

Fig. 3 represents the case of two conductors lying in a closed slot, current flowing up one and down the other. The effect in each conductor will be the same as if we had but one conductor lying in an

open slot, of which the mouth was at PQ, except for the fact that the tendency of the lines to bow outward at the mouth will here be largely neutralized. Curves in Fig. 3 show the distribution of current and loss[1] density in the conductors, it being assumed that $f = 50$; $\frac{d}{a} = 0.61$; and b has the values 1.875 centimetres, 3.75 centimetres and 7.5 centimetres. We will now proceed to show, as briefly as possible, how such calculations are made. Let $\Delta_o \sin pt$ be the nominal current density in each conductor, so that $bd\,\Delta_o \sin pt$ represents the total current flowing in the conductor. Let us confine our attention to the left hand conductor in Fig. 3, and consider x as distance measured from the root of the conductor toward the centre of the slot. Within the length of the slot the current density will be disturbed, hence let Δ be the actual instantaneous value at x. Let ρ = specific resistance in ohm-centimetres.

Where the conductor emerges from the slot the current will redistribute itself and become uniform, and the potential at all points of the conductor in any plane parallel with the plane of lamination (of iron) will be the same.

Consider two such planes, one at each end of the iron armature, but just far enough outside for the current to have become uniform, and let the distance between them be l centimetres; and the potential difference be v. Remembering that the flow of current in the conductor within the slot is lamellar, Ohm's law for the current at x will be $v + Vl_1 = \Delta\rho l$, l_1 being the length of the slot plus an allowance for fringes at the ends.

V and Δ are functions of x, but v is independent thereof, hence differentiating we have:

$$\frac{d\,V}{d\,x} = \frac{l}{l_1}\rho\frac{d\,\Delta}{d\,x} \qquad (1)$$

If C be the total current in the conductor between the limits $x = 0$, $x = x$, the induction density at x will be $\frac{4\pi}{10}\frac{C}{a}$. The total current in the conductor between the limits $x = 0$ and $x = x + \delta x$ is $C + d\,.\,\Delta\delta x$, and the induction density at $x + \delta x$ will be

$$\frac{4\pi}{10}\left(\frac{C + d\,.\,\Delta\,\delta\,x}{a}\right),$$

d being the thickness of the conductor; hence

$$\frac{d\,B}{d\,x} = \frac{4\pi}{10}\cdot\frac{d}{a}\,\Delta, \qquad (2)$$

V being the electromotive force induced at x per centimetre length by the cross flux, is equal to $\frac{d\,N}{d\,t}\,10^{-8}$, where N is the total number of lines which may be considered as surrounding the imaginary lamina at x, as above defined, but $\frac{d\,N}{d\,x} = B$.

Hence $$\frac{d\,V}{d\,x} = 10^{-8}\frac{d\,B}{d\,t}. \qquad (3)$$

Equations (1), (2) and (3) are the fundamental equations of the problem; we can now eliminate V and B and obtain

$$\frac{d^2\,\Delta}{d\,x^2} = \frac{4\pi}{10}\cdot\frac{d}{a}\cdot\frac{l_1}{l}\cdot\frac{1}{\rho}\cdot 10^{-8}\frac{d\,\Delta}{d\,t} \qquad (4)$$

It is then proved that

$$\Delta = \delta_1 \epsilon^{mx}\sin\left(p\,t + m\,x + \beta_1 - \frac{\pi}{4}\right) + \delta_2 \epsilon^{-mx}\sin\left(p\,t - m\,x + \beta_2 - \frac{\pi}{4}\right) \qquad (5)$$

where $$m^2 = \frac{2\pi p}{\rho}\cdot\frac{d}{a}10^{-9}.$$

It is easy to see that, where we have only one conductor in the slot, or the equivalent, as in Fig. 3, $\delta_1 = \delta_2$ and $\beta_1 = \beta_2$;

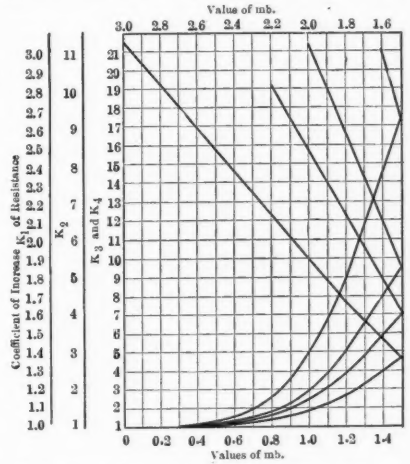


FIG. 4.—CURVES SHOWING COEFFICIENT OF INCREASE IN RESISTANCE.

but where there is more than one conductor in the slot, carrying current in the same direction, δ_1 and β_1 will differ from δ_2 and β_2 respectively, for all but the lowest conductor. The values of $\delta_1\,\delta_2\,\beta_1\,\beta_2$ for any conductor are determined by the two conditions:

1. That the total current flowing or integral of current density over the cross-section of the conductor $= d.b\,\Delta_o \sin pt$.

2. That the cross induction at the root of the conductor, or where $x = 0$, equals

$$\frac{4\pi}{10}\cdot(n-1)\frac{d.b}{a}\Delta_o \sin p\,t,$$

where $(n - 1)$ is the number of conductors below the one in question.

In the single-conductor case we have

$$\left.\begin{aligned}\delta_1 &= \frac{m\,b\,\Delta_o}{\sqrt{\cosh 2\,m\,b - \cos 2\,m\,b}},\\ \text{and}\quad \tan\beta_1 &= \frac{\tanh m\,b}{\tan m\,b}\end{aligned}\right\} \qquad (6)$$

for which the curves in Fig. 3 are plotted.

The important fact to determine is how much greater is the actual ohmic loss due to the ununiform distribution than the nominal loss, or that calculated on the assumption of uniform distribution.

For this purpose we have only to consider the maximum values of the current at varying depths, and do not need to trouble about the relative phase relations. The maximum value of the current density at x, as derived from (5) and (6), is

$$\sqrt{2}\,m\,b\,\Delta_o\sqrt{\frac{\cosh 2\,m\,x + \cos 2\,m\,x}{\cosh 2\,m\,b - \cos 2\,m\,b}}. \qquad (7)$$

The values of the current density at different points of the solid conductor shown in Fig. 3 are plotted corresponding to the three cases $mb = 6$, $mb = 3$ and $mb = 1.5$. If we take $\frac{d}{a} = 0.61$, $f = 50$, then $m = 0.8$, and the above values will correspond to depths of conductor 7.5 centimetres, 3.75 centimetres and 1.875 centimetres, respectively. Where there are more conductors than one in a slot, current flowing in each in the same direction, these effects are greatly magnified in the upper conductors.

It must be borne in mind that the phase of the current is not the same at all points of the conductor, but a continuous change of phase occurs from one edge to the other. For example, in the case where $mb = 3$, the current at the outer edge (P.Q) is forty-five degrees in front of the load current; while the current at the root of the slot lags 127 degrees, making a total phase difference of 172 degrees between the current at mouth and root. In Fig. 3 the values of the square of the current density have also been plotted, showing how enormously the loss density increases toward the outer edge of the conductor. The mean height of these loss-density curves, or what is the same thing; the ratio of the area of the actual to the nominal loss-density curve, represents the coefficient of virtual increase of resistance of the conductor, or the ratio of the actual to the nominal ohmic loss.

This ratio will be the mean square value of expression (7) taken over the cross-section, divided by Δ_o^2. Calling this value K, we have

$$K = m\,b\,\frac{\sinh 2\,m\,b + \sin 2\,m\,b}{\cosh 2\,m\,b - \cos 2\,m\,b}. \qquad (8)$$

This value, derived from the equations of the single-conductor case, will apply only to the bottom conductor, where there

[1] The loss density at a point is the loss per cubic centimetre at that point.

are more than one in a slot, carrying current in the same direction.

In the case of several conductors one above the other, each carrying the same total current, counting the lowest 1, the second 2, and so on, it can be shown that:

$$K_n = mb\left[\frac{4(n^2-n)\cosh mb - \cos mb)(\sinh mb - \sin mb) + (\sinh 2mb + \sin 2mb}{\cosh 2mb - \cos mb}\right] \quad (9)$$

It will thus be seen that the constant by which the nominal ohmic loss per centimetre must be multiplied, in order to determine the actual loss in a given conductor, or the coefficient of increase of resistance, depends entirely upon the depth of the conductor, the frequency, specific resistance and the ratio of d/a.

The formulæ (8) and (9) have been utilized for the calculation of curves in Fig. 4, corresponding to $n = 1$, $n = 2$, $n = 3$, $n = 4$, *i. e.*, for cases where slots contain one, two, three and four conductors connected in series, current flowing in the same direction in each. These curves are plotted from the results of Mr. A. B. Field, given in his paper on eddy currents, presented at the Asheville convention of the American Institute of Electrical Engineers, June, 1905. The curves apply merely to that part of the conductors lying within the slot, and show how many times the actual loss is greater than that calculated from Ohm's law. As examples illustrative of the use of these curves we will take the case of a four-layer winding, the depth of each conductor being one centimetre, frequency fifty. Let d/a be 0.61; we have then $m = 0.8$. Referring to the values of K corresponding to $mb = 0.8$ for the first, second, third and fourth conductors, respectively we obtain the values 1.04, 1.3, 1.85 and 2.6; that is to say, that while the nominal loss is increased by the idle current effect to the extent of four per cent in the lowest conductor, it is increased 2.6 times in the topmost conductor.

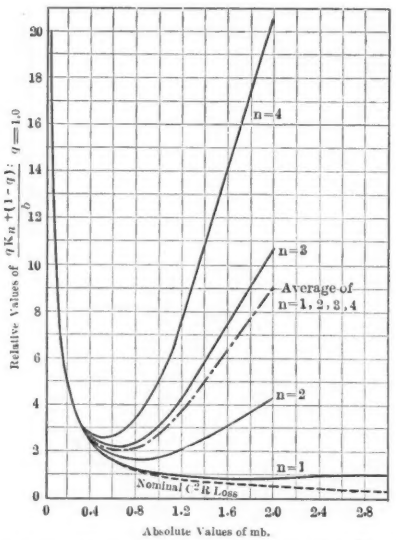


FIG. 5.—CURVES SHOWING ACTUAL AND NOMINAL LOSSES IN ARMATURE CONDUCTORS.

When we find in any machine that the idle current loss largely exceeds the nominal loss, and bear in mind that the one increases while the other decreases with the copper section, we are naturally led to enquire whether an actual diminution of the amount of copper may not improve the efficiency. Suppose q is the ratio of the active length of the conductor to the length of a half-turn. Let us now keep a, d, C and all other dimensions the same, varying only b, and for the present let us call $m = 1$. The nominal loss per centimetre length is P/b where $P = \frac{\rho C^2}{d}$ and the actual average loss per centimetre is $\frac{P}{b}(qK+(1-q))$ where K is the coefficient corresponding to the value mb. If we plot P/b vertically and b (or mb where $m = 1$) horizontally, we obtain, of course, a rectangular hyperbola. If, now, we multiply each value of P/b by the corresponding value of $\{qK + (1-q)\}$ we obtain the actual loss for each value of b, m being unity. This curve shows a minimum value—*i. e.*, there is a certain critical value of b giving minimum loss, and this critical value is evidently independent of the value of C. If we double b, the nominal loss is halved, but if at the same time we halve m, the K coefficient remains unchanged, hence the curve last referred to applies equally well for $m = 0.5$, if for any given point of the curve we multiply the reading of the abscissa by two, and the reading of the ordinate by a half. Of, if we consider that the abscissa represent values of mb instead of b, we do not need to change their scale.

Hence, we observe that for all values of m the point of minimum of the curve occurs at the same value of mb. Figs. 5 and[1] 6 show these curves plotted for $n = 1$, $n = 2$, $n = 3$, $n = 4$, $q = 1$, and $q = 0.5$.

These curves show the relative losses when m is kept constant at any value and b is varied, but it must be remembered that when m is changed, the vertical scale is changed proportionately. They show, moreover, the value of mb at which minimum loss always occurs.

In Figs. 5 and 6 we have also shown the relative values of the nominal loss, as also the average value of the four curves for $n = 1$, 2, 3 and 4.

Referring to Fig. 5, where $q = 1$—*i. e.*, for the case where the whole length of conductor is active, it will be seen that no matter what current we require to take out of the conductor, the minimum loss for the lowest is obtained when $mb = 1.4$, for the second when $mb = 0.8$, and so on.

If, now, we put

$$f = 50, \quad \frac{d}{a} = 0.61$$

so that $m = 0.8$, the critical depths of conductor are 1.75 centimetres, one centimetre, 0.8 centimetre and 0.7 centimetre for the 1st, 2d, 3d and 4th respectively. Any additional depth means an increase of loss and a waste of copper, no matter how large a current the machine may have to supply.

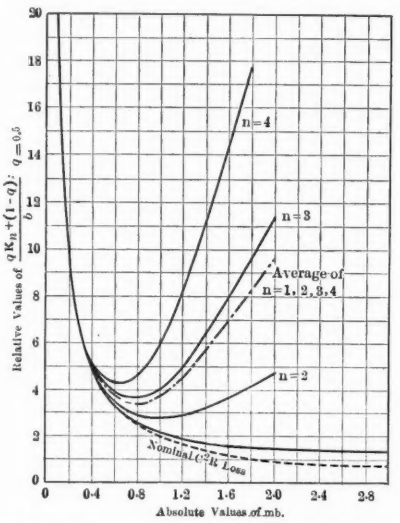


FIG. 6.—CURVES SHOWING NOMINAL AND ACTUAL LOSSES IN ARMATURE CONDUCTORS.

It also follows that if this critical depth be exceeded, an increase of specific resistance may decrease the loss, hence that the efficiency of the machine may actually improve as the temperature increases.

In Fig. 6 the curves correspond to $q = 0.5$—*i.e.*, where half the total length per turn is active. The average-loss curve connects mb and

$$\Sigma_{n=1}^{n=4} \frac{q\,K_n + (1-q)}{4\,b}$$

This curve obviously shows the critical value of b for a coil of four layers of solid conductor. For the same value of m as above, this critical value works out $b = 1$ centimetre.

Although we have determined the

[1] As mb increases K_n approaches the value mb $[2(n^2 - n) + 1]$; it follows therefore, that the curves, if extended, will turn over horizontally and approximate to the straight line of which the ordinate is constant.

critical depth for a four-layer coil, provided the same section of conductor is used throughout, a little consideration will show that by grading the section of the conductor in the different layers a still better arrangement may be arrived at. Remembering that when $mb = 0.8$ a depth of one centimetre has already passed the critical value of the outer layer, and has not yet reached that for the lowest layer, it follows that a more efficient arrangement will be obtained by transferring some of the copper from the outer to the inner layer.

In determining slot and conductor dimensions there are, of course, other important factors which need due consideration. For example, the heat generated in the active part of the conductor is, to a large extent, conducted to the end connections, at which it is dissipated by ventilation and radiation. A large cross-section of conductor forms a better conductor thermally, and may tend to reduce the

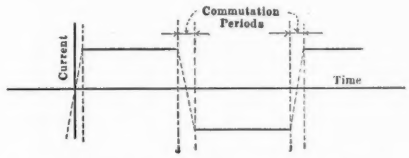


FIG. 7.—APPROXIMATE CURRENT IN A DIRECT-CURRENT ARMATURE.

maximum temperature within the active portion. Again, it has been urged that a deep conductor is sometimes advisable for mechanical considerations owing to the very great mechanical forces which may be exerted on the end connections, and yet, again, the suggestion has been made that a certain amount of idle current in the conductors is useful in that it reduces the reactance of the whole winding.

We have so far only dealt with the lamellar effect in connection with alternating-current machines. When we consider, however, that the current flowing in the armature conductors of direct-current machines is in reality an alternating current, we see that the above results, with certain modifications, are also applicable to direct-current machinery. We do not propose to enlarge the scope of this paper unduly by entering upon a lengthy discussion of the critical depth, temperature gradient, etc., of direct-current armature conductors, but merely to indicate the lines upon which these considerations may be investigated. Confining our attention to a particular armature conductor of a direct-current machine, we remember that the current is flowing in one direction when the bar is passing under a N-pole, and in the opposite direction when passing under the S-pole. The change of direction is effected during the commutation period. The current value at any instant during this period is somewhat indefinite, but the period is of relatively short duration. Fig. 7 may be taken as representing the current in any armature conductor where the dotted portion is substituted for the unknown which occurs during commutation.

If, as an approximation, we take the current in each bar as being equivalent to

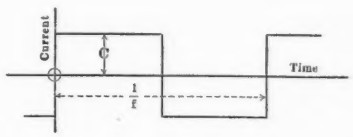


FIG. 8.—ASSUMED CURRENT IN A DIRECT-CURRENT ARMATURE.

that shown in Fig. 8, the case is capable of fairly exact computation. Let C be unity, then the current at any instant is given by

$$\frac{4}{\pi}\left(\sin p\,t + \frac{1}{3}\sin 3\,p\,t + \frac{1}{5}\sin 5\,p\,t + \text{etc.}\right),$$

where $p = 2\pi f$. We thus have a number of sine wave alternating currents of differing frequencies flowing in each bar, and, as already pointed out, we can calculate the loss due to each as if it existed separately. There is, therefore, no difficulty in supplying our previous curves and formulæ. Take the case of a six-pole, 500-revolutions-per-minute, direct-current generator, f will be 25 cycles per second. We must, therefore, calculate the value of $m\bar{b}$ for $f = 25$, 75, 125, etc., and calling the corresponding K_n values respectively ${}_1K_n$, ${}_3K_n$, ${}_5K_n$, etc., where the suffix determines the position of conductor in slot (*i.e.*, 1st, 2nd, or nth), and the prefix determines the frequency term of the Fouriers series.

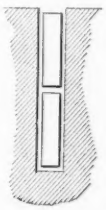


FIG. 9.—TWO-LAYER DIRECT-CURRENT WINDING.

The coefficient of increase of resistance for the nth conductor carrying the current shown in Fig. 8 will then be given by the expression

$$\frac{8}{\pi^2}\left[{}_1K_n + \frac{1}{9}\left({}_3K_n\right) + \frac{1}{25}\left({}_5K_n\right) + \text{etc.}\right]$$

In general the K values for solid conductors of direct-current machines will be greater than those for conductors of the same depth in alternate-current machines running at the same speed and having the same number of poles, because in the direct-current machines the current is largely composed of higher-frequency terms, and, secondly, since direct-current machines are generally constructed for lower voltages, less space will be occupied in the slot with insulation. Fig. 9 represents a two-layer winding in a direct-current armature. The K value of the active portion of the upper conductor calculated from the first seventeen terms of the above series is 2.5, f being taken at 25 cycles per second. The K value for the lower conductor is 1.26, and for the whole winding 1.44, assuming as before $q = 0.5$.

Unfortunately this series is not very rapidly convergent.

The K values for the higher frequency terms may be calculated from the expression

$$m\,b\,[2\,(n^2 - n) + 1].$$

In the armature of a rotary converter, the effect is still more pronounced, since the higher frequency terms are more predominant.

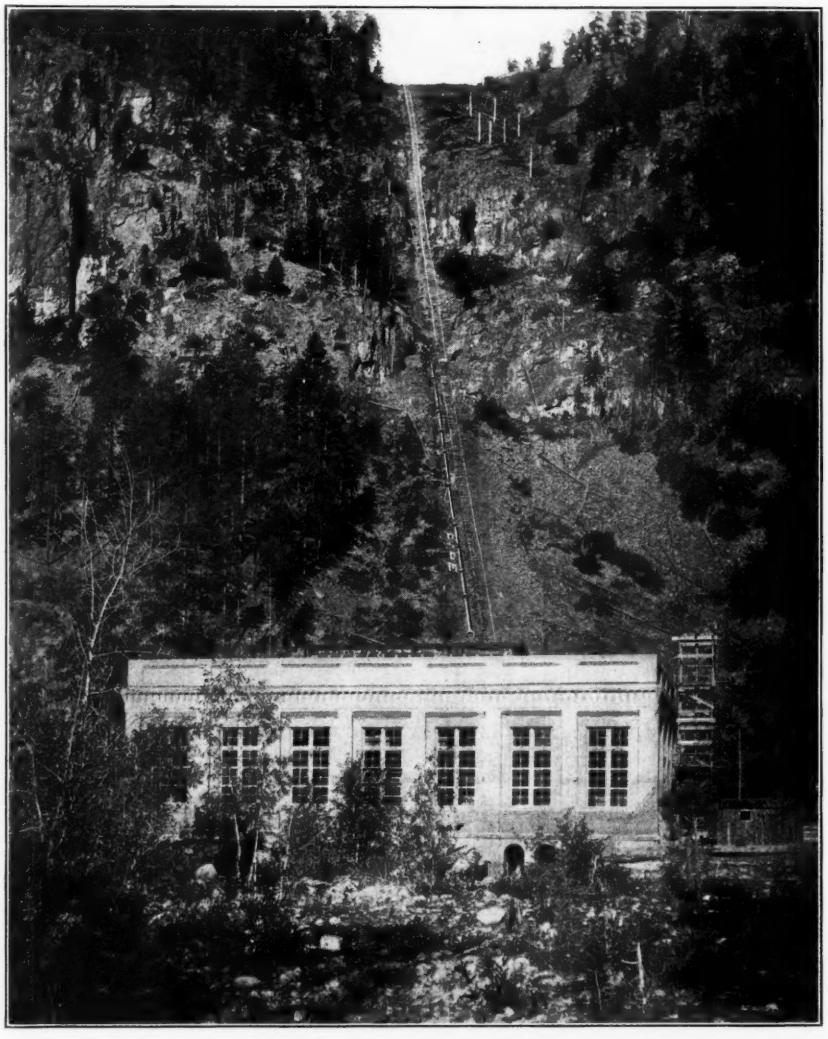
The Recent Municipal Election in Chicago, Ill.

On April 3 a municipal election was held in Chicago, Ill., among other things deciding several questions regarding the municipal control and operation of street railway utilities in the city. The city declared for municipal ownership of street railways, but not for municipal operation. The vote for municipal operation was defeated by 10,651. On the question of public policy submitted to the people as follows, "shall the city council proceed without delay to secure municipal ownership of all street railways in Chicago under the Mueller law instead of passing the pending franchise ordinances or any other ordinances granting franchises to private companies," the vote was 111,662 for, to 108,025 against. Upon the question of issuing $75,000,000 of Mueller law certificates, the majority was 3,339 in favor. The Mueller law was passed by the legislature several years ago, authorizing the issuing of certificates to be used for the purchase of public utilities by any city wishing to undertake the purchase and operation of its utilities.

The Hydroelectric Plant of the Animas Power and Water Company.

By Malcolm Lloyd.

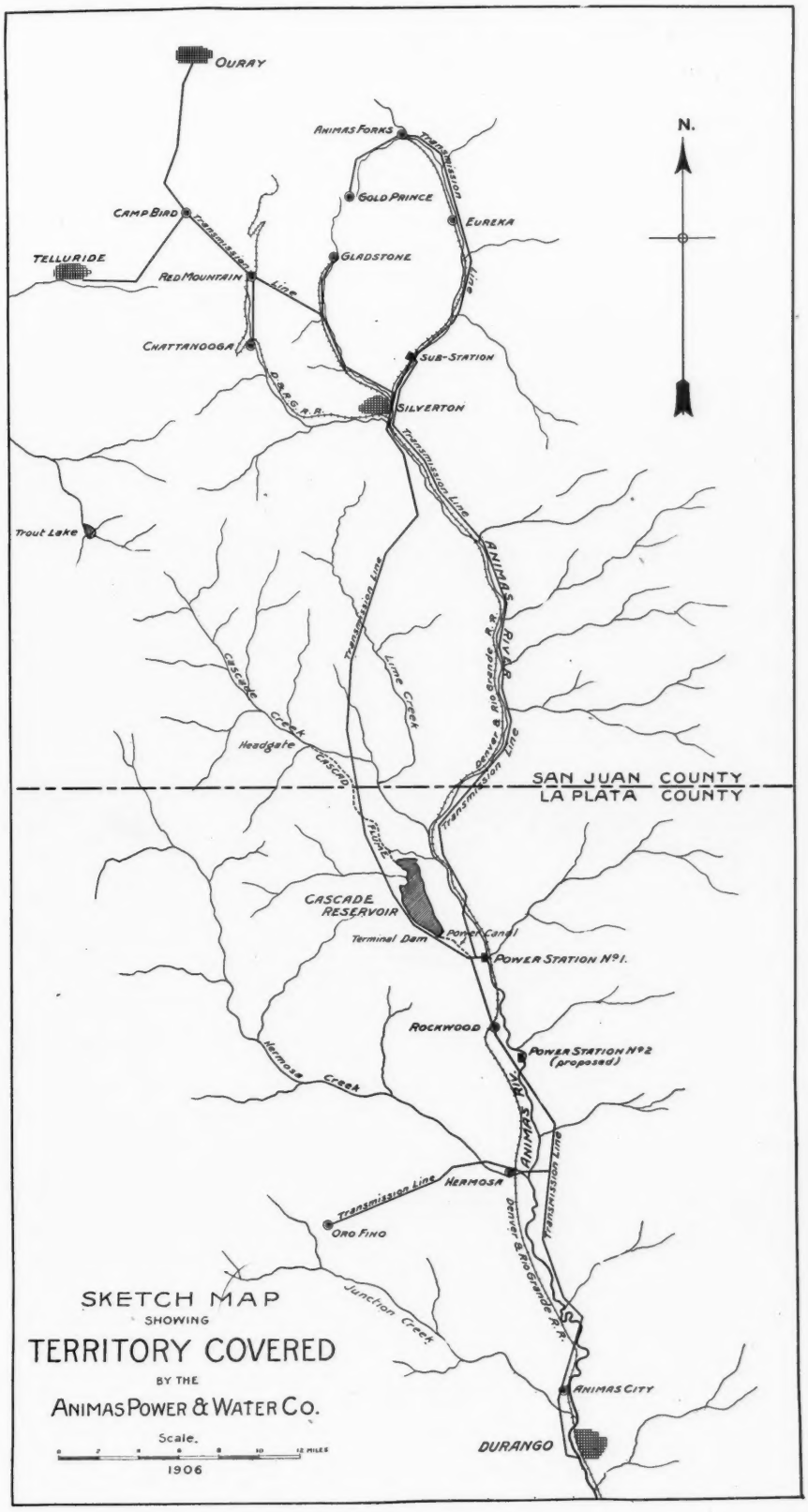
IN the southwestern part of Colorado, in La Plata and San Juan counties, there has recently been constructed a hydraulic power plant that promises to eventually revolutionize the mining and commercial industries of this great undeveloped region. The mines of the "San Juan" are in the most rugged and picturesque mountain region of the United States, and have been most aptly termed the "Switzerland of America." Mining is carried on principally for gold, silver, lead and copper, which occurs in large and continuous veins. While the values often run exceedingly high, the average is of medium grade, necessitating milling and concentration requiring considerable power. This power, furnished at a low cost, will improve the industrial conditions in this region a hundredfold, permitting development work hitherto impossible with limited capital. Larger and established mines will also share in the benefits, as is already shown in the great Camp Bird and Guggenheim properties where individual power plants have been superseded. It was with this idea in view that the Animas Power and Water Company constructed its plant near Rockwood on the Animas river, having a static head of 1,000 feet, which develops an electric current at 50,000 volts and transmits it north to the camps of Silverton and south to Durango, a distance approximating forty-five miles. Investigations as to the possibilities of developing sufficient power to meet the present and ultimate demand were inaugurated in the summer of 1902. There were many novel and perplexing problems that presented themselves for solution. The first and most serious perhaps was the variation of flow in the streams of this semi-arid section of the country, most of the precipitation being in the form of snow and occurring in the winter and spring months, while the summer and fall are usually dry. The streams are thus dependent for supply from the melting snow in the mountains. This is conducive to exceedingly high water in the early summer and extremely low waters in the fall and early winter months. The fluctuations in the Animas river and the mean out discharges are from 122 cubic feet per second in December to over 8,000 cubic feet in June. The daily variation is, in many instances, 100 per cent during the winter season. This is due to the freezing and thawing of the streams during the twenty-four hours. As the average discharge in the Animas river was about 700 cubic feet per second, while the minimum discharge during the winter nights would probably be twenty-five second feet, it was found impossible to construct a water power plant which could deliver power twenty-four hours of the day and 365 days in the year, unless storage of the flood waters could be had, for the mills and mines of this region run twenty-four hours every day in the year. Owing to the rough topography, which is exceedingly steep and broken, it was a difficult thing to find a suitable site for storage purposes capable of carrying a dry-weather supply of water. A plateau about 1,000 feet above the Animas river was finally selected as most available, for here was a large basin about three and one-half miles in length and nearly a mile in width which admitted of being dammed to the height of 100 feet, and when full would give a maximum of three and one-half billion cubic feet of water. As only about twelve square miles of watershed were tributary to this large basin, it was evident it could not supply sufficient water, and it then became necessary to divert other waters to supply the deficiency. It was found that in order to divert the Animas river into this basin a ten-mile flume or an eight-mile tunnel, of which the longest single drift would be five and one-half miles, would have to be constructed.



POWER-HOUSE, PIPE LINE AND CONSTRUCTION TRAMWAY ALONGSIDE PIPE LINE, ANIMAS POWER AND WATER COMPANY.

Lime creek, a tributary of the Animas river, could also be diverted into this basin as well as Cascade creek. After

careful surveys it was found that Cascade creek could be most economically diverted into the basin, and on this basis was taken as the initial point for development of the plant. Above the intake dam on Cascade creek the drainage area is about thirty square miles, which lays at an altitude of 10,000 to 13,000 feet, and over this area the snowfall is considerable. It was estimated that from this source and the twelve miles tributary to the reservoir and eight miles tributary to Little Cascade creek that 6,000 horse-power could be supplied with a fall of 1,000 feet. It was found that a storage of one and one-quarter billion cubic feet of water was necessary in order to carry the plant over a dry season, which is from four to six months. The capacity of the reservoir is sufficient to run the plant about five months.



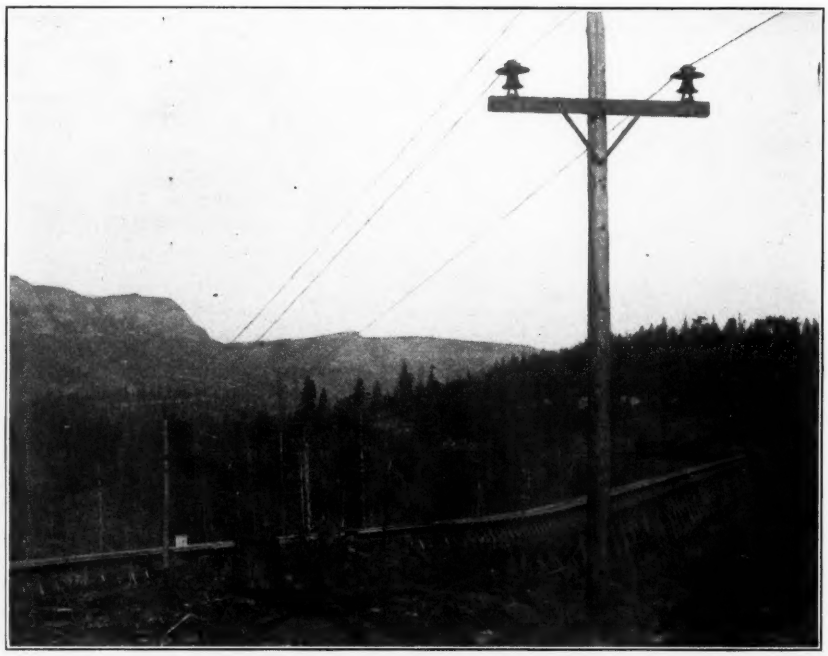
The diversion of the water of Cascade creek is effected by the construction of a wooden flume six feet deep and eight feet wide in the clear and three and one-half miles in length, having a flow of 480 cubic feet per minute. This diverts the water into Little Cascade creek, and the natural bed of this stream is utilized for a distance of two and one-half miles; the water is then taken out by a flume the same size as above, but which is laid on a steeper grade; this empties the water into Cascade reservoir at the north end, this reservoir being artificial and having an area of 960 acres. The drainage basin supplying this reservoir has a run off of 4,500 cubic feet per minute, making a total supply of 4,980 cubic feet per minute at flood water. At the other extremity of the lake, three and one-half miles distant from the north end, the principal dam is constructed, and from this point a two-mile flume leading to a small supply reservoir, from which the pipes conduct the water to the power-house below under 1,000 feet of head. This flume has a yoke for thirty inches, which is supported on two longitudinal stringers supported for seven and one-half feet. The yokes are composed of a four by eight sill with four by six posts and cap; each yoke has a knee brace of two by four. The box of the flume, unlike the Cascade flume, is composed of one board two inches thick and eight inches wide when finished. The joints between them are made tight with a slip tongue. This flume is also covered for the same reasons as the Cascade flume. The Cascade flume is laid on a grade of two-tenths of a foot to each 100 feet, and all curves were accurately located by instrument. Except in two instances no curves steeper than forty degrees was used. The carrying capacity of the flume was figured from Kuter's formulæ, using "n" = 0.012; this gives results slightly too small with the new flume, but with age it will be nearly correct. As this flume lay high up in the mountains, which were covered with snow six months in the year, all of the work had to be done in the latter part of the summer and fall. It was necessary to put in saw mills to manufac-

ture the lumber on the ground, as it was impossible to haul it in. This lumber was delivered along the line at the most convenient points, and the construction of the flume progressed accordingly. Mules worked inside the flume to convey the lumber from these accessible points out to the workingmen.

The Cascade flume has three longitudinal stringers supported for six feet. The side stringers were four by eight feet, the centre stringers six by eight. Every six feet a yoke composed of six by six timbers was framed, with a knee brace on the outside to keep it in position. Between these braces were two four by six feet yokes without knee braces. The box of the flume was composed of two thicknesses of one-inch boards laid with broken joints. The flume was covered so as to prevent the sun shining in during the summer and also to prevent water freezing during the winter months. The flume was built from practically four working points, and was begun in July and finished in the following February, 1905. The flume leading from Little Cascade creek to the reservoir differs only from the Cascade flume in that it is laid on a grade 45/100 of a foot to each 100 feet. This is to allow for the surplus water from Little Cascade creek. The reservoir dam is what is known as a crib dam. It is fifty feet above ground and thirty-three feet below the surface to bed-rock, is 750 feet long on the crest, and the spillway is through the granite rock on the east side of the dam. The dam is ninety feet wide at its base and forty feet wide on top, and is constructed of cribs and round logs ten feet between centres. Each log is bolted to the next one underneath it by a three-quarter-inch pin, these cribs were then filled with rock. The up-stream side is vertical and is made tight by three thicknesses of boards nailed to the facing log, which were hewed down to receive them. The boards next to the logs are two inches in thickness, and upon this is laid a layer of tarred felt, then two layers of one-inch boards with joints broken. The two-inch boards are to support the tarred felt, which is only supposed to withstand slight water pressures when the reservoir is filling in the spring, so it was thought that after the water had been drawn down during the fall and winter the boards would shrink, allowing leakage. The tarred felt is only intended to withstand a water pressure of two or three feet and was interposed to overcome this temporary difficulty, for when the reservoir filled again during the spring it was calculated the boards would swell and thus become sufficiently tight and practically impervious. Ultimately this dam will be replaced by a more permanent structure of concrete 100 feet high and 1,400 feet long, which will increase the area of the reservoir to 1,161 acres, giving over 3,000,000,000 cubic feet of water. By the additional diversion of the waters of Lime creek the total water supply will be increased to 10,440 cubic feet per minute, and this will be accomplished by building a flume four miles long. As the demand for power increases it is proposed to get additional water from the Animas river through a tunnel eight miles long, giving ultimately 40,000 horse-power.

Two thirty-six-inch pipes encased in concrete afford the means of drawing off the water, and these pipes are placed so that fifty feet in depth may be drawn off. The supply is controlled by rock sluice-gates at the inside of the dam. This pipe discharges into the Little Cascade flume three feet two inches deep by four feet eight inches wide, which carries the water to the supply reservoir 8,800 feet distant.

This flume line is constructed over much better ground than the Cascade flume and is much more accessible, though there are several bridges and trestles upon this line. The inverted siphon was not used on account of freezing in cold weather, if the flow in the flume should be shut off for any reason, as the temperature here is frequently twenty-five to thirty degrees below zero. Like the Cascade flume the lumber had to be manufactured on the ground, and in places where the lumber could not be delivered in wagons it was carried through the flume on buggies pulled by men. The dam forming the supply reservoir, from which the steel pipe leads, is constructed of earth, with a three-foot core of concrete and a concrete wall at the toe. This rests upon solid bed-rock. The filling on the up-stream side is earth, with eighteen inches of rip-rap on top. It is thirty feet high and about 100 feet long. This will be raised an additional ten feet, which will then give an effective head of 1,000 feet at the power-house. The pipe to the power-house leaves the intake reservoir at a point twenty-five feet below the surface of the water, thereby avoiding the possibility of ice engorgement or blockading the entrance to the pipe. The opening of the pipe inside of the dam is sixty inches in diameter, which is at once reduced to forty-four inches, and this continues until a head of 125 feet is reached, when the diameter is further reduced to forty inches and again down to thirty-six inches and thirty-four inches, respectively. The thickness of the pipe varies from one-quarter of an inch at the dam to eleven-sixteenths of an inch at the power-house. The riveting is varied to correspond to the pressure to which the pipe is subjected. The pipe is intended to carry seventy feet of water per second. The total length of the pipe is 2,844 feet, of which 800 feet is on top of the hill and very nearly level. Its descent to the power-



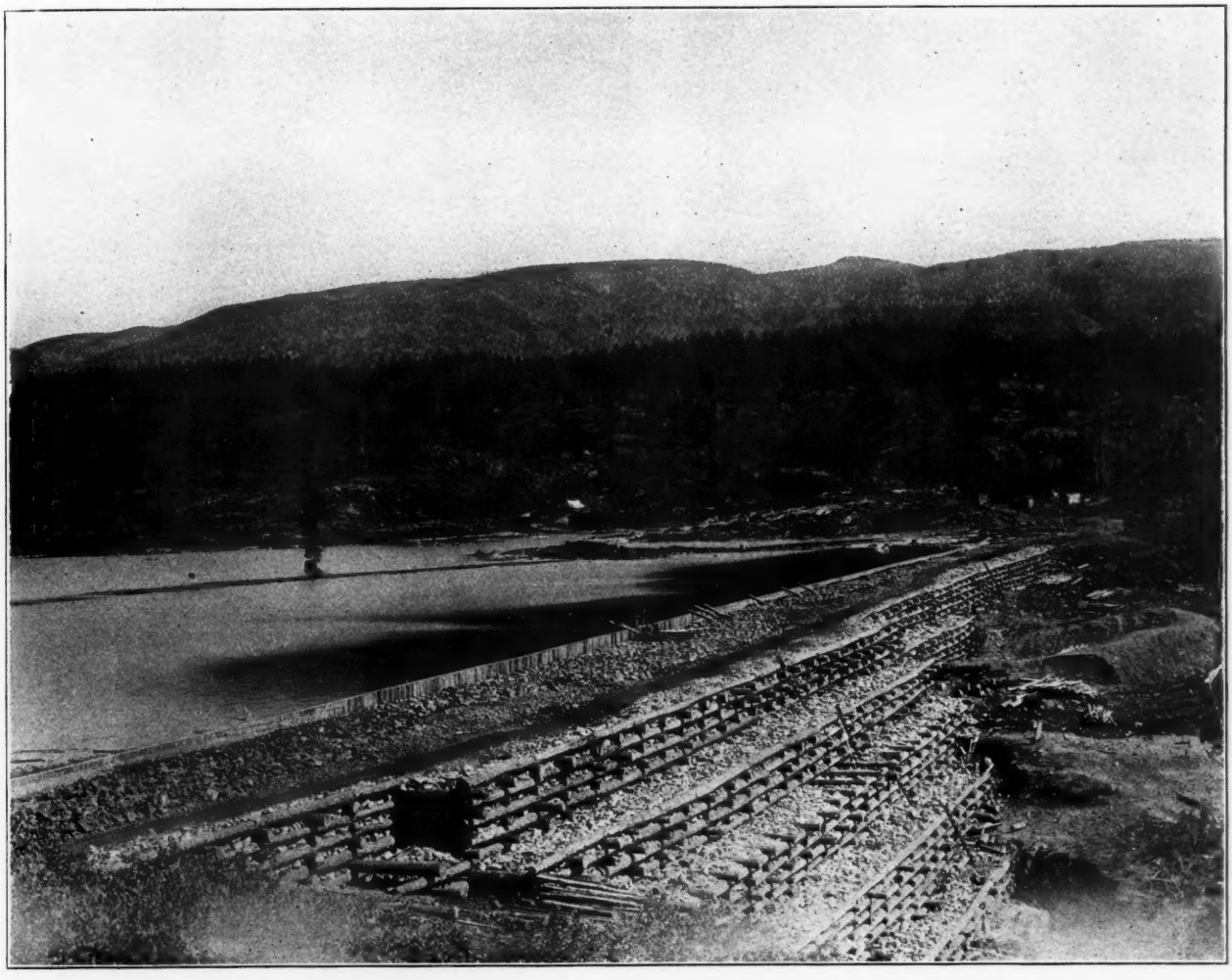
FLUME ON TRESTLE, AND TRANSMISSION LINE, ANIMAS POWER AND WATER COMPANY.

house is probably one of the steepest pipes, considering its size, that has ever been laid, having a maximum grade at this portion—its descent to the power-house—of eighty-four per cent.

The pipe is composed of thirty-foot sections fitted with welded steel angle flanges, which are bolted together with combination lead and copper gaskets between them. The largest sections weigh six tons each. At the power-house and lower bends the pipe is anchored in large blocks of concrete, each block being of sufficient size to carry the weight of the pipe above it. The sections of the pipe at the lower end were tested to 650 pounds per square inch. In addition to the large concrete blocks at the foot of the incline for taking the downward thrust, the pipe is securely anchored in position by additional concrete masonry distributed along the line. At the lower end of the pipe there is a cast steel Y tapering to two twenty-inch branches connecting to twenty-inch gate valves, with by-passes and roller bearings for connection to the needle nozzles of the wheels.

The placing of the pipe in position developed some unique methods besides considerable danger to those employed, but happily the work was completed without an accident of any kind. The sections of the pipe were delivered along the trench from an inclined railway, which was operated by a mine hoist and cable at the top of the hill. The track was laid from the top down and was a very difficult undertaking, as all ties and rails had to be held while they were being fastened together. Some points of the grade of this railway were over 100 per cent grade, and it was a difficult task to lay the pipe on account of it being almost impossible to prevent rocks from rolling down the hill.

The power-house building is constructed for four generators, only two of which have been installed. The wheels are eight feet Pelton wheels, overhung on the generator shafts and have a normal capacity of 3,000 horse-power each. The wheels run at 300 revolutions per minute and are capable of being run up to 4,000 horse-power each. The wheel centres, and also the buckets are made of cast steel. Each bucket is bolted to the centre with one two and one-quarter-inch and one one and three-quarter-inch bolt, giving ample strength to permit the wheels being locked and the full stream turned on. The shafts are fourteen inches in diameter at the bearings and sixteen inches in diameter at the fields. The shafts have a five-inch hole through them, through which water is run to assist in keeping the bearings cool. The bearings are forty-two inches long and are made with only the lower half babbitted. The upper part has a cover with guides for the oil rings, of which there are six to each bearing. In the lower part of the bearings are coils of pipe for water cooling. The nozzles are by-pass needle nozzles. Power given to the wheels varies as the ordinates of a curve for a uniform motion of the needle, and in order that the power delivered to



Crib Work and Dam, Animas Power and Water Company.

the wheels may vary uniformly for a uniform rotation of the governor shafts, a system of toggle levers is arranged so that the needles will move as the ordinates of a curve when the governor shafts are rotated uniformly. In order to avoid water hammer on the pipe when the load is thrown off the generators, there is a by-pass arranged to be opened by the governor when it closes the nozzle on the wheel. The wheel nozzle needle and by-pass nozzle needle are connected together by means of a right and left-hand screw with a hand-wheel, so that the station attendant by means of a predetermined load curve can set the screw at certain hours of the day in order that the amount of water passing will be sufficient for the average amount of power required and reduce the loss to a minimum. The wheels are controlled by oil-pressure governors, with two pumps so arranged that one can furnish power for either or both in case of an accident to one of them.

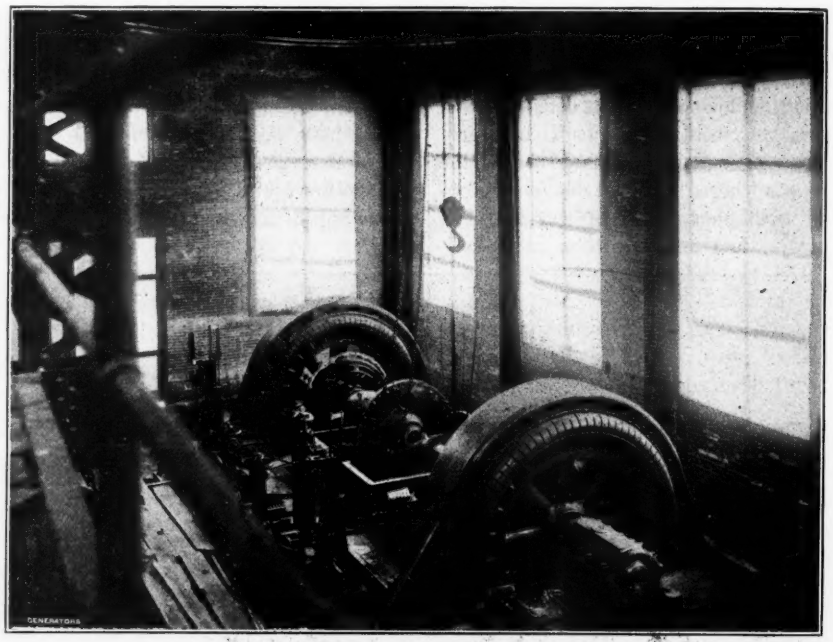
The generators are 2,250 kilowatts, revolving field, three-phase, sixty-cycle alternators, with the exciter armatures mounted on the shafts. The generator voltage is 4,000, which is raised by step-up transformers to a line voltage of 50,000.

There are six water-cooled transformers of 750 kilowatts capacity each. Each transformer is located in an iron and cement vault, completely closed, so that in case of damage by lightning, the oil can not burn and damage the building or apparatus.

The generators are supplied with voltage regulators, which obviate any difficulty in keeping the voltage constant with the exciter armatures on the generator shafts. The generator mains pass up to the oil switches and circuit-breakers through brick chambers, whose walls form barriers.

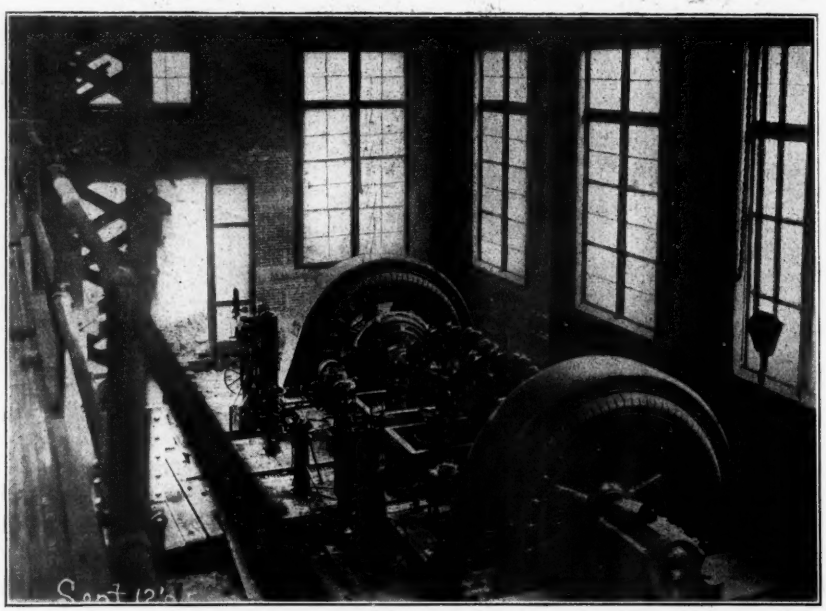
Each transmission line passes through a separate brick chamber to the exterior of the building. The switchboard is located in a gallery over the transformer vaults, where the attendant has in full view all the machinery in the building. The two additional generators subsequently to be installed will have double the capacity of the present ones and will give 18,000 electrical horse-power. Two additional pipe lines will be necessary, however, to supply this power, and then the Animas river will be required. All electrical machinery was supplied by the General Electric Company, Schenectady, N. Y. The pipe and water-wheels were furnished by the Pelton Water Wheel Company, of San Francisco, Cal.

The power is transmitted to the sub-station at Silverton, twenty-five miles from the power plant at Rockwood. The voltage of these duplicate lines is 50,000. The transmission line is made of three



GENERATORS AND WATER-WHEELS, SHOWING METHOD OF FASTENING BUCKETS, ANIMAS POWER AND WATER COMPANY.

cables, each composed of six aluminum No. 8 Brown & Sharpe wires with a hemp core. These cables have a conductivity equal to that of No. 2 Brown & Sharpe copper wire. They are arranged on poles to form a triangle with six-foot sides. The poles are thirty-six feet long, set six feet in the ground and spaced 250 feet apart. The insulators used were made in two parts and cemented together with a mixture of one part Portland cement and one part sand. A cast-iron pin was also cemented in the insulator and was fastened to the cross-arm by a three-quarter-inch bolt. The idea of duplicate lines was to maintain uninterrupted service, so one line goes up the Animas canon and the other over the country. This was necessitated by the numerous and destructive snow slides which are quite frequent in this country. It was also imperative to use unusually long spans, some of the long-



GENERATORS AND PELTON WATER-WHEELS, ANIMAS POWER AND WATER COMPANY.

est reaching a length of 1,100 feet. Many of these lines had to go through canons and over mountains, which made it almost impossible to protect the poles and towers from snow slides. In one instance a canon about one and one-half miles was followed where it was impossible to keep the line on either side of the canon, due to the fact that the slides which came from above the cliffs upon either side would pour down upon the line, even though it missed the supports. In this case it was necessary to cross and recross the canon and to carry the lines upon wooden towers sixty feet in height, having a twenty-foot base at the bottom, with each leg securely bolted to a block of concrete containing one and one-third cubic yards, except in cases where the tower legs could be anchored to bed-rock. In this manner it was possible to carry the line through in such a manner that the slides could not destroy it.

A great deal of the wire was strung with the snow varying from three to five feet in depth on the level, and in many places it had been drifted to considerable depth. It was slow and tedious work. In places where it was possible to use horses to break the trail along the line this was done, six horses being used for this purpose. In places, however, the hills were so steep that horses could not be used at all, and the trail had to be broken by men. It was practically impossible to work on snow shoes.

Special towers are constructed to carry the lines where the span exceeds 400 feet in length. The substation at Silverton reduces the voltage to 17,000 and it is distributed at this voltage. Another substation is to be built in Durango at an early date. All distribution circuits have copper conductors, and in one instance where the line had to cross over a very high divide reaching an altitude of 13,500 feet, very steep and precipitous in places, a copper cable was used composed of seven strands.

Cast-iron pins were used for the insulators, the top pin being bolted on the side of the pole and the side pins fastened to a four-inch by six-inch cross-arm. The triangle on the 17,000-volt line was reduced to four feet. The distribution circuits are more subject to damage from snow slides than are the main transmission lines, for the mountains here are much higher and steeper. In some places along these lines snow often accumulates in slides to a depth of sixty to 100 feet. Over such places special towers were constructed and a line was carried in one instance 1,280 feet.

The foregoing is based upon data furnished by Mr. H. T. Henderson, chief engineer of the Animas Power and Water Company; that portion relating to the power plant from Mr. Geo. M. Peek's article in *Engineering News* for January, who installed the hydraulic machinery. Credit is also due to the various gentlemen connected with the work for valuable assistance.

CASCADE FLUME, ANIMAS POWER AND WATER COMPANY.

The Portland (Ore.) General Electric Company has adopted plans for a power plant at Oregon City, involving an expenditure of $2,000,000. Work will begin this summer on the plant, which will be located at the east end of Willamette river falls.

THE COMING POWER.

BY E. R. KNOWLES.

The cost of production of manufactured articles depends mainly on three elements, the cost of power, of materials and of labor, and the lower these costs can be made the more satisfactory is the cost of production, and any means by which the cost of any or all of these elements can be reduced is a distinct gain.

The element of power is perhaps the most vital of all, depending as it does on so many variables and particularly on the initial source from which it is derived.

The constant endeavor at all times has been, and is, to produce power at the lowest cost, and countless methods for so doing have been devised.

Natural forces, such as the wind, the heat of the sun, the flow of water and the tides have been utilized with more or less success, but these forces are either too inconstant and irregular in their action or are not widespread enough for general use.

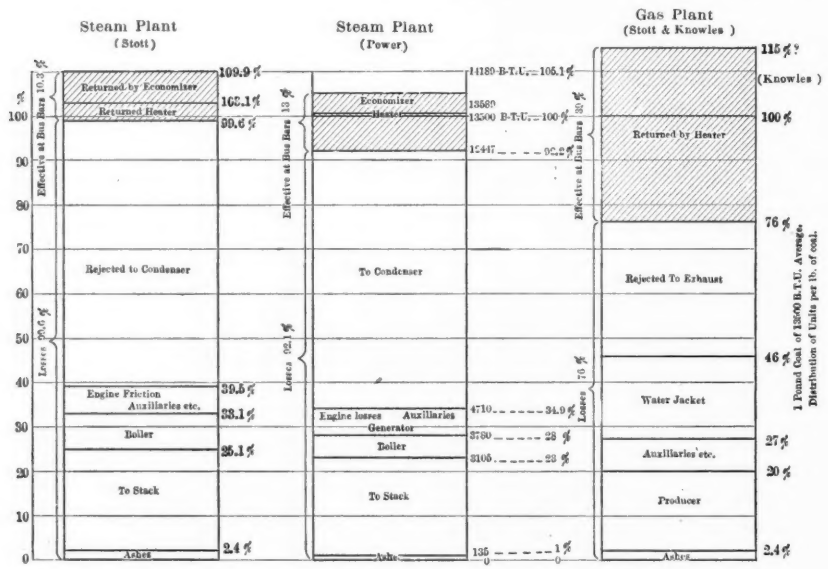
The combustion of various substances, as fuel and the utilization of the heat thus generated, appears to be the most satisfactory source of power, and the greater portion of the efforts to produce power cheaply have been directed to various methods of heat application.

The most popular form of such heat application and the one which has been up to recent times carried to the greatest point of refinement is the steam plant, in which the heat of the fuel is utilized to heat water, turning it into steam, and the steam in turn used to operate an engine constructed for that purpose.

But even in the most carefully constructed and operated steam plants the efficiency of conversion of the heat into power is extremely low.

When it is considered that a pound of coal has an average of about 13,500 thermal units and that under the very best conditions in the most modern of steam plants about 12,500 thermal units or about ninety-two per cent are lost in obtaining the useful effect of the remaining 1,000 units and that this ratio is even greater in the average steam plant, it will be realized how great this loss is.

The illustrations, Figs. 1 and 2, show diagrammatically the ways in which this energy goes to waste in a steam plant.



FIGS. 1, 2 AND 3.—ENERGY LOSSES IN STEAM AND GAS POWER PLANTS.

The reason for the enormous loss lies in the large number of transformations and apparatus which the thermal units have to pass through before the desired result is obtained, and in the system itself, which is inherently inefficient. The combustion in the furnace, the radiations from the boiler, piping, auxiliary apparatus and engine, the waste gases in the chimney, the waste steam in the exhaust, the condenser and other auxiliaries all claim their quota, and so large a one that very little is left for useful effect. The truth is that the source of power is, so to speak, too far removed from the point of application.

The nearer to the point of application the fuel can be utilized and the greater the number of these intermediate transformations that can be eliminated, the less will be the losses, and consequently the greater will be the useful effect.

In order to accomplish this desired result the effort has been made, and quite successfully, to burn the fuel directly at or in the engine and thus eliminate all of the intermediate steps and utilize to the utmost the full value of the thermal units in the fuel.

The *ultima thule* of all investigators in this line of work is the direct production of power from the fuel itself, but this to-be-hoped-for method has not as yet been discovered.

The nearest approach to this ideal condition is the internal combustion engine, a form of engine in which the fuel is burned in the cylinder and there acts directly on the piston to produce power.

This form of engine, commonly known as the gas engine, has been very greatly perfected, and has now reached a point of economical and satisfactory operation which leaves but little to be desired.

A variety of fuels have been used in these engines, such as gasoline, kerosene, fuel oil and natural, illuminating, water and producer gas, blast furnace and coke oven gas, but the fuels most commonly used are gasoline, fuel oil and illuminating gas, and increasingly at the present time, producer gas.

While cheap fuels, such as gasoline, fuel oil and natural and illuminating gas have given the internal combustion engine a rapid and unusual precedence over all other forms of engines, it is still necessary, in order to make its use as universal as possible, to have a fuel which can be obtained at any desired point, independently of any natural source or of any fixed point of manufacture and distribution, and one which can be made from the cheapest material which can be obtained and utilized.

Such requirements have resulted in the introduction of the gas producer and what is commonly known as producer gas, undoubtedly the cheapest and most economical fuel in general use at the present time.

The gas producer is, in reality, only what might be called a convenient form of apparatus for manufacturing gas, using as a source a great variety of materials, such as peat, lignite, wood, charcoal, coke, anthracite and bituminous coals, and in fact any and all kinds of carbonaceous materials; the chief material and the one most commonly used being anthracite and bituminous coals.

Fig. 3 gives in diagrammatic form the ways in which the energy in a gas engine producer system is dissipated and the amount of useful effect obtained. It will be seen that while the losses of energy

are still large, the percentage of useful effect has been greatly increased and that it is possible by this combination to secure as high possibly as thirty per cent effective return at the point of power application.

This, as compared with the best possible effective return as given by Mr. H. G. Stott and shown in Fig. 1, which gives about ten per cent effective return, shows an enormous gain in efficiency, the ratio being about three to one.

If one were asked to name the power which was considered commercially the cheapest at the present time the answer would almost invariably be, hydraulic power.

The following table gives the comparative commercial costs of power from various sources:

COMPARATIVE COSTS OF POWER PER BRAKE HORSE-POWER YEAR.

Engine.	Fuel.	Price.	Fuel Consumed per B.H.-P. per Hour.	Fuel Cost per B.H.-P. Hour.	Fuel Cost per B.H.-P. Year.
Gas	Producer gas	Anthracite pea coal, $3 per ton.	1¼ pounds.	$0.001875	$13.00
Gas	Natural gas.	25 cts. per 1,000 ft.	15 cubic feet.	0.00375	15.25
Gas	Crude oil.	cts. per gallon.	1/10 gallon.	0.004	16.00
Gas	Gasoline.	.2 cts. per gallon.	1/10 gallon.	0.012	40.00
Corliss condensing	Coal (Bitum.)	$3 per ton.	3 pounds.	0.0045	43.50
Turbine condensing	Coal (Bitum.)	$3 per ton.	3 pounds.	0.0045	43.50
Gas	Illuminating.	90 cts. per 1,000 ft.	18 cubic feet.	0.018	58.00
Slide valve (simple)	Coal (Bitum.)	$3 per 1,000 ft.	8 pounds.	0.012	66.00
Electric current (central station)	.....	3 cts. per kw hour	.....	0.0225	71.00
Hydraulic	.....	.....	.....	.....	29.00

From this it will be seen that power produced by the gas engine producer system is fully as cheap as hydraulic power, and it has been stated by Mr. C. E. Sargent, of Chicago, that, from recent investigations made by him, power generated by the gas engine producer system may be as much as ten to fifteen per cent lower in cost than hydraulic power.

Now what has really been accomplished by the introduction and use of the gas engine producer system of power production?

In the first place the gas engine producer system is universally adaptable because it can utilize any form of fuel material; it can be installed at any point where fuel material and water can be obtained, and it is not dependent on any form of manufactured commodity for its maintenance and operation.

Next it is cheapest because the initial cost of the installation is low; the cost of building room or floor space occupied is a minimum; only a small fuel storage is required; a small amount of water is needed, and this water can be used over and over again; the lowest grades of fuel materials can be employed, and the thermal value of the fuel material utilized to the utmost; the fuel can be burned exactly at the point of power generation, and a very large proportion of the thermal losses due to transformations be prevented; the cost of maintenance and repairs is reduced to a minimum and the standby losses are low.

Then the producer-gas system is simple and compact because the apparatus is self-contained, the space occupied is small, the erection and arrangement of the system is not complicated and there are few parts, no chimney or high-pressure steam boilers are necessary, the piping system is simple and very little auxiliary apparatus is required.

The system is efficient also because of the uniform quality of the fuel used; no fuel is wasted; the fuel is consumed in proportion to the load; perfect combustion of the fuel is attained at the point of power production; a very high per cent of the thermal units in the fuel is utilized in the production of power; the same thermal efficiency can be had in small as in large installations; fuel storage in the most compact and valuable form can be had without any loss of energy in the fuel stored, and the thermal losses in transmission in the system are reduced to a minimum.

It is safe because there is no high-pressure steam boiler required, no high pressure in the piping, no danger from fire or explosion, it can be started and stopped instantly and there is perfect and automatic control of the system.

It is sanitary because no smoke or deleterious vapors are given off, and the installation is clean, unobtrusive and not a nuisance in the neighborhood.

Its repairs and maintenance are low because the installation is simple and has few parts; there is no high pressure in the system and no leaky joints, valves, etc., to be made good; the standby losses and wear and tear are reduced to a minimum; no licensed engineer or firemen are required, and no skilled labor is necessary for the producers.

The attendance and attention required is small because the fuel and ash is centralized, all being handled at one point; the installation is always ready to operate, is automatic in operation; there are no delays for cleaning or starting fires or getting up steam, and the system can be operated continuously on long runs without injury, breakdown or adjustment.

Briefly stated, in the gas engine producer system we have a source of power production that is almost universally adaptable to all conditions of environment and application, which is the cheapest in cost of any power production known at the present time, is simple and compact in arrangement, is the most efficient, is safe, is sanitary, has a low cost of maintenance and repairs, calls for a minimum of attendance and attention, requires no licensed labor, is always available and ready for use and is in every way more nearly fitted for universal application for power purposes than any other source of power production known at the present time.

These qualities render the gas engine producer system especially valuable not only for future power applications, but also as a substitute for present power installations which are now operated by steam or other forms of power.

This system of power generation is not only as fully applicable to all purposes where power is required as is the steam engine, but is really more so, for while it can do all that the steam engine can do, it can be more universally applied.

There are many situations, notably in office, loft, factory and other buildings where there is not space enough to install a steam plant on account of its size, but where the gas engine producer plant, on account of its compactness, can be placed to the greatest advantage.

There are also very many manufactories and central power distributing plants which are now operated by steam power at a loss or are barely holding their own, which by remodeling and by the substitution of the gas engine producer plant for the steam plant can be placed on a paying basis, and this is one of its greatest fields of application.

An objection which may be made to the gas engine producer system is the necessity, where it is required to heat a building, for placing therein a special heating system for that purpose.

Where a steam plant is used the exhaust steam from the engine is usually utilized to heat the building, and thus a saving is accomplished by the use of what would otherwise be a waste.

With the gas plant no such condition exists; there is no steam which can be

utilized for heating purposes and a separate heating system must be installed; but even with this drawback the economy and advantages of the gas plant are so great that the heating system can be added and still leave a large margin in favor of the gas plant.

Doubtless, as time passes, still further improvements will be made in the gas system, and means will be found whereby the large percentage of waste, which still exists in this system, may be utilized for heating purposes and this objection finally removed.

Finally, while the gas engine producer system is still far from the desired ideal system, nevertheless the great gains in efficiency and lowering of cost production shown by this system and its many advantages are such that with its advent the gas engine has made such rapid strides as a prime mover, and its adoption to power generation has given so much satisfaction not only from an economical point of view, but also for continuous and hard service, that it bids fair to revolutionize all present methods of power production and to become the legitimate successor of the steam engine and steam system.

An Occult Use of the Telephone.

A trick is going the round under guise as a feat of telepathy which, when first met, causes much surprise. The victim is told that if he will select a card and call up the telephone operator at a certain branch exchange she will tell him the card selected.

The trick is as susceptible of explanation as any jugglery. The young lady at the private branch exchange has more aliases than a criminal, and makes answer to the spots on the card according to the name by which she is addressed.

For example, the scheme of names may be as follows: if the joker has been selected, call for Miss Smith, who replies accordingly; for other cards direct your friend to call any of the following, according to the card which he has selected, and the reply will be accordingly:

Spots.	Hearts.	Diamonds.	Spades.	Clubs.
		(Name to Be Called.)		
1	Brown	Collins	Adams	Keenan
2	Burns	Cumings	Anderson	Kellar
3	Baker	Clark	Alcott	King
4	Bates	Cleary	Alexander	Kennedy
5	Browning	Clayton	Allen	Kerr
6	Bright	Clements	Allison	Kessler
7	Briggs	Clifford	Andrews	Keyser
8	Brooks	Crocker	Arms	Kingman
9	Bock	Coleman	Arnold	Knapp
10	Beeker	Carrigan	Armond	Kirkman
King	Bell	Connelly	Ashton	Kline
Queen	Bender	Connor	Atkinson	Knight
Jack	Bennett	Cook	Ayers	Knox

Like many other wagers this may overstep the amenities of games by "betting upon a certainty," yet in a smaller way it may furnish a source of satisfaction to those who delight to puzzle their friends.

A Brooklynite on Mount Vesuvius.

A recent despatch from Rome, Italy, to the Brooklyn *Eagle* states that Professor Matteuci, director of the Vesuvius Observatory, has "gratefully acknowledged the assistance and praised the courage of Frank A. Perret, the electrical engineer of Brooklyn, N. Y., who remained with him throughout the eruption."

Mr. Frank A. Perret is a well-known electrical engineer who has been in Italy about a year and a half. In 1899 Mr. Perret invented a storage battery, and, owing to the development of this apparatus and other work which he had in hand, was seized with a severe attack of nervous exhaustion. He was confined to bed for about nine months, and when, a few months after, he was able to be moved, upon the advice of his physician he went to Italy, remaining there during that winter and returning to New York the following spring. Again taking up active work before fully recovering, he was prostrated within a few months. It was decided that he should return to Italy for an indefinite period. He has been in that country now about a year and a half on this last trip. Mount Vesuvius has always had a strong fascination for him, and it is understood that he has taken a remarkable series of photographs and has written considerable concerning the volcano. Within the last few months he was appointed honorary assistant astronomer at the observatory on Mount Vesuvius.

Early in his career Mr. Perret was associated with Thomas A. Edison in his experimental laboratory. Later he formed a partnership with John A. Barrett, now one of the engineers of the American Telephone and Telegraph Company. Mr. Perret invented the Perret motor and dynamo, which machines subsequently became the product of the Elektron Manufacturing Company, of Springfield, Mass. Just before his illness Mr. Perret invented an automobile and electric launch motor, the details of which have not yet been completed. The model is, however, in the hands of Parsell & Weed, New York city. Several of these motors have been built, and they give excellent results. In 1899 Mr. Perret was associated with Mr. William H. Meadowcroft in the storage battery business, the late Theodore Berdell being interested with them.

Charles Perret, of 37 Maiden lane, New York city, Mr. Perret's father, received a letter from his son at Vesuvius, dated April 2, stating that everything was very quiet. A cablegram, dated April 9, was received stating that Mr. Perret had gone through the eruption unhurt, was quite well and that the indications were that the possibility of danger was over.

For a New Fire-Alarm System in New York City.

In the issue of the ELECTRICAL REVIEW, October 14, 1905, an abstract was given of the report covering the conditions of the fire-alarm telegraphs in New York city. This report showed the great need for a rehabilitation of the service. Last week John H. O'Brien, commissioner of the New York City Fire Department, sent the following letter to the mayor, asking for an appropriation of $1,625,000 for the purpose of affording a service such as was suggested by the commission appointed last year:

The fire-alarm telegraph system in the borough of Manhattan has been in operation for a long period of time, and for several years past its efficiency and adaptability to the present requirements of this great section of the municipality have at recurring intervals been the subject of discussion in the public prints. Indeed, it is but reasonable to assume in view of the great progress that has been made in electrical science since the introduction of the system, that it might be materially improved with resulting advantage to the public.

My predecessor in office, as the result of a preliminary enquiry made by him into the subject, became satisfied that there was considerable room for improvement, but that to arrive at the actual state of affairs would necessitate an exhaustive and costly investigation by qualified experts in this line of work, and therefore when it was proposed by the New York Board of Underwriters, which naturally was deeply interested in the matter, that such an enquiry should be conducted by that body at its own expense, he accepted the proposition with the approval of his honor the mayor.

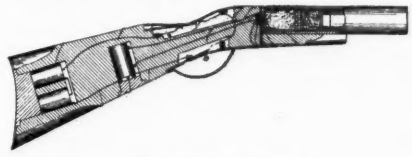
Mr. Kempster B. Miller was selected by the underwriting authorities to conduct the investigation, in the capacity of electrical engineer, with Mr. John J. Carty as consulting engineer, and every facility was afforded them by this department for the successful prosecution of their task.

As a result of their investigation, extending over a period of several months, these experts submitted a report on the subject, in which they reached the conclusion that the total cost of an adequate system of fire-alarm telegraph protection for the borough of Manhattan would be about $1,625,000, exclusive of the ground for the central office, for which no estimate was submitted.

I have therefore the honor to request that the Board of Estimate and Apportionment authorize an issue of corporate stock to an amount not exceeding $1,625,000, for the purpose of establishing, building and equipping a fire-alarm telegraph system for this department in the borough of Manhattan, in accordance with the estimate made in the abridged report of the committee on fire-alarm service to the New York Board of Fire Underwriters, bearing date September, 1905.

Electrical Patents.

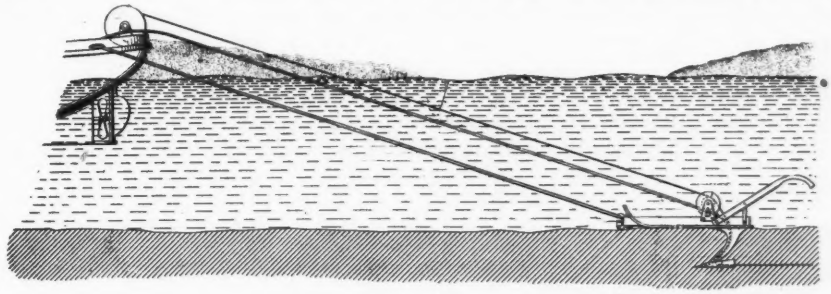
An improved electrical gun has been invented by Martin E. Thomas, of Batavia, N. Y., and he has assigned one-half to Frank Fishel, of Batavia, N. Y. (815,490, March 20). This invention relates to guns, and more particularly to electrical guns, and has for its object to provide a gun equipped with an electrical apparatus, including a novel arrangement of parts constructed to ignite a charge of powder within a gun. Another object is to provide a gun equipped with a safety stop



Electrical Gun.

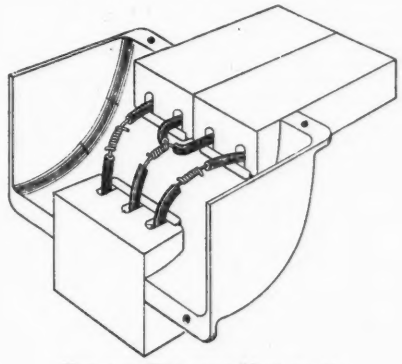
movable to lie at times in position to prevent premature discharge of a gun. The invention consists in the combination with a stock having a chamber there within and having a longitudinal slot in its upper portion communicating with the chamber, of contact plates disposed at opposite ends of the slot, a plate slidably mounted for movement into and out of position to contact with both of the first-mentioned plates, simultaneously, a shank secured to the slidable plate and extending outwardly through the slot, means for holding the sliding plate yieldably out of operative position, a make-and-break, electrical connections between one of the stationary plates and a member of the make-and-break, a battery, electrical connections between the battery and the other of the stationary plates, an induction coil carried by the stock, electrical connections between coil and battery, electrical connections between the coil and the other member of the make-and-break, means for operating the make-and-break, a metallic breech-block for the gun, an insulating body in the breech-block, a contact piece in the insulating body and extending through the forward face of the breech-block, electrical connections between the contact piece and the induction coil, and electrical connections between the breech-block and the induction coil.

An improved apparatus for laying electric conductors has been invented by Samuel Proal Hatfield, New York, N. Y. (815,163, March 13). The object of the invention is to provide a new and improved apparatus for laying and burying electric conductors on land and under water in a very simple and comparatively inexpensive manner to prevent the conductors from being fouled by the anchors of marine vessels and to prevent the conductors from being easily detected or grappled and cut in time of war. The invention consists in the combination with a propelling vessel, of a plow having a port leading out through the front of its point, a flexible connection between the plow and the vessel to drag the plow along, means for directing the conductor from the vessel to the plow and into the furrow made by the plow, and a hose leading from a forced water supply on the vessel to the rear of the plow-standard and connected with the port in the plow-point.



Apparatus for Laying Electric Conductors.

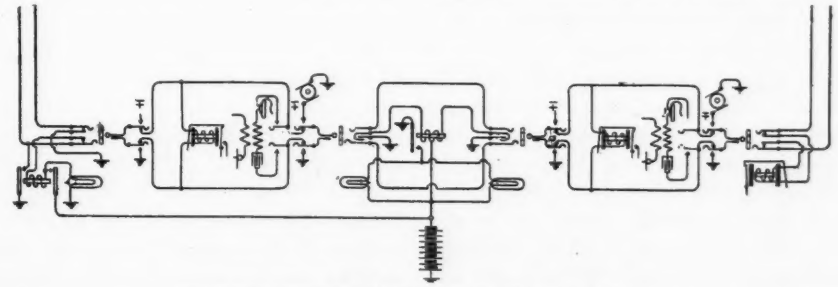
John L. Gleason, Jamaica Plain, Mass., has obtained a patent (814,906, March 13) for an improved box for electric mouldings. The object of this invention



Box for Electric Mouldings.

is to provide a cheap, simple and convenient box for joining together, covering and clamping to supporting walls mouldings for electric wires and for enclosing and protecting the portions of the electric wires which extend from one moulding to another. A reduction-box for electrical mouldings comprising in its construction two end-plates joined together by a curvilinear front-plate, integral therewith, the front-plate provided in each of its opposite edges, respectively, with a recess, one of these recesses being larger than the other, the recesses each having two ends connected by a longitudinal side and a beveled corner connecting each of the ends to the sides at opposite ends thereof, respectively.

Chas. A. Simpson, Chicago, Ill., has obtained a patent (816,131, March 27) for an improved transfer circuit for a telephone exchange system, and he has assigned it to the Kellogg Switchboard and Supply Company. This invention relates to improvements in transfer circuits for telephone switchboards, more particularly to such transfer circuits and means for readily signaling between the operator to facilitate the handling of such connections from an operating standpoint. Naturally the greatest field for such invention is in connection with small magneto switchboards or magneto lamp switchboards, or with small non-multiple common battery switchboards or in the combination of these various types, where in the changing from one system to the other or in adding a new section of an improved type of line to an old style switchboard it is necessary to interconnect the various types of lines. It is not intended, however, to limit the invention to these uses, since it is apparent that it may be employed in various relations and under various conditions. The invention consists in the combination with subscribers' lines terminating upon different switchboard sections of a transfer circuit extending between the sections, means at each section to connect the subscribers' lines thereof with the transfer circuit to establish a complete talking circuit between the subscribers, two signals permanently connected in parallel, associated one with each end of the transfer circuit, and means actuated in making and unmaking connections with the transfer circuit for suitably controlling the circuit of the signals.



Transfer Circuit for Telephone Exchange System.

Reviews of Current Engineering and Scientific Literature.

The Preservation of Boiler Tubes.

A brief description is given here of the electrogalvanizing plant used for coating tubes for the boilers installed in the vessels of the British navy. Galvanizing also assists inspection as well as protects the tubes, since it is found that a thin covering of zinc shows up defects and faults which would not otherwise be detected. In this process electrogalvanizing is rapidly superseding the old dipping process. The plant consists of a number of tanks about twenty-six feet long, six and one-half feet wide and nine feet deep, in which pipes of all dimensions can be coated. The tubes to be coated are first flashed with zinc for the purpose of inspection. They are then returned to the galvanizing bath and zinc deposited to a thickness of one and one-quarter ounces per square foot. Condenser tubes are coated in the same way, both inside and outside. The Cowper-Coles regenerative process is used. In this the electrolyte is circulated through the galvanizing tank, being drawn from a regenerator and carried off into a sump. From the latter well it is pumped back into the regenerator, where it is mixed with zinc dust and in this way brought back to the original concentration. The regenerator is a vessel, the bottom part of which is filled with a filter bed consisting of a mixture of zinc dust and coke. In the plating tank lead anodes are used, so that no foreign bodies are introduced into the solution, as would be the case if zinc were used for this purpose; and, moreover, the zinc dust employed in bringing the solution back to the proper concentration is inexpensive, and there is no loss due to disintegration of the anodes.—*Abstracted from the Engineering Times (London), March 22.*

How to Improve Telephony.

An excellent summary is given here of an address delivered recently by Mr. W. Duddell before the Royal Institution, of Great Britain, on methods of investigating telephone problems. After explaining the action of telephone apparatus, the point was made that in telephony, as well as in any other applied science, accurate measurements afford the best hope for further perfection. In the past the perception of what occurs in a telephone has been largely intellectual and could not be either seen or measured; and in spite of this the instrument has attained a great and surprising measure of efficiency and commercial success. We possess excellent transmitters and receivers, but the line problem is difficult. It is owing to the length of the line that the currents arrive either too feeble to operate well or too distorted. In order to ascertain where improvements are needed it is necessary to study the movements of all parts with the aid of measuring instruments. The amplitude of the diaphragm vibrations has been measured by Mr. P. E. Shaw by means of a delicate micrometer. The moving object strikes the first of six levers arranged in a row, and the stroke of the last lever is measured with the aid of a micrometer screw. A contact of platinum-iridium is fixed at a certain distance from the diaphragm. When the diaphragm is spoken into a click will be heard in an auxiliary telephone as soon as the diaphragm touches the contact, and the distance may then be read off on the screw. The results show that just audible sounds deflect the diaphragm through a distance of about 0.7 $\mu\mu$ (millionths of a millimetre). Comfortably loud sounds give deflections of about fifty $\mu\mu$. Uncomfortably loud sounds give deflections of about 1,000 $\mu\mu$ and overpowering sounds 5,000 $\mu\mu$. To test the line steady, high-frequency currents are sent through it. Sound waves are not steady enough, nor are the oscillations of tuning forks, even if electrically driven. For this purpose a microphone buzzer has been designed by Mr. A. Campbell. It consists of a straight steel bar about one foot long and one square inch in section, resting near its ends on two small steel tubes, each provided with a slit. The buzzer gives currents of 2,000 periods of almost pure sine curves of great constancy. An ingenious form of condenser is used in demonstration work. It consists of sheets of tinfoil and paper arranged in a bag form. The capacity can be changed by varying the number of sheets and by pressing them more or less tightly together. Another apparatus used by Mr. Duddell is a high-frequency alternator which is driven by means of two phosphor-bronze discs, themselves driven by electric motors. A belt guided so as to form the figure 8 takes all strain from the machine spindle. In this way Mr. Duddell has produced currents of 120,000 cycles per second. Telephone currents are measured by a thermo-detector, the current being passed through a short wire directly underneath the suspended loop of a Boys' radio-micrometer. By means of the oscillograph the shape of the telephone current waves was shown and also the distortion caused by the constants of the line.—*Abstracted from Engineering (London), March 23.*

Speed Characteristics and the Control of Electric Motors.

A practical synopsis of the various methods of speed variation of electric motors is given here by Mr. Charles F. Scott. The application of electricity produces two kinds of types of effects. In the first place the same results which were accomplished by former methods may be secured at a reduced cost and with greater convenience. In the second place new results may be secured through the use of electricity. In fact, as a general result, its introduction leads to new methods which secure a greater output and increased excellence. The introduction of the motor into the machine shop has resulted in new methods of applying power and controlling it, which have not only increased the output of the tool, but have reacted upon its design so that new methods have been worked out, leading to radical advances. As long as reasons for adopting electric transmission in factories were limited to improvements in the transmission system, it did not have a very attractive future, as the total cost of supplying power in many large factories is but a small per cent of the total cost of manufacture. It was difficult, therefore, for the electric motor to make much headway when its field was limited to reductions in the cost of an item which was but four or five per cent of the total. On the other hand, when it was appreciated that the motor, by means of its speed adjustment and other characteristics, could increase output, improve products and materially reduce labor cost, then the real usefulness of the motor was recognized. The motor is useful not because it reduces power demands, but because it enables greater power to be used effectively. The rapidity of the changes which have taken place in machine shop practice, most of which are closely associated with the electric motor, is one of the striking features of recent mechanical and electrical development. One of the principal features which makes the motor useful and successful is mechanical rather than electrical. This feature is speed control. Mechanical devices

for varying the speed of a machine have been found wanting. In fact, if the mechanical engineer desires to make speed changes other than of the most simple kind he is pretty sure to leave his own field and seek the solution in the electric motor. Mr. Scott discusses the factors in the electric motor which affect its speed, and points out that the shunt motor is essentially a constant-speed machine, and that when such motors are arranged to be run at different speeds it would be more proper to call them adjustable-speed motors rather than variable-speed motors, as is the custom to-day. The practical limits of speed adjustment of shunt motors is determined by the design of the motor. As a general thing motors having a wide variation are heavier than those designed for one speed only. The various methods of speed control, such as varying the field strength, varying the applied voltage, etc., are discussed at some length, and the conclusion is reached that there are several points in favor of control by variation in the strength of the field when adjustable speeds are desired, which speeds are to be independent of load variations. There are certain limits to the several methods of speed variation. Variation of the field strength is limited by the physical characteristics of iron and copper. The iron becomes saturated, and with heavy exciting currents the coils may get hot. The electromotive force applied to the armature has a certain maximum limit, depending on the windings and design of the commutator and the current which can be commutated, and consequently that which can be passed through the armature is limited by the sparking at the commutator. There is also a limit to armature speed which is purely mechanical, as the centrifugal force must not be great enough to tear the machine to pieces. —*Abstracted from the Engineering Magazine (New York), April.*

Electric Winding Plant for a Shale Mine.

The Scottish shale industry some years ago suffered severely from the competition of American and Russian oils, but has taken on renewed life since the companies have adopted modern methods in extracting the material and in utilizing the by-products. A typical case of this is illustrated by the equipment erected at the Cobbinshaw pit, fifteen miles from Edinburgh. This pit is 140 yards deep, and when fully developed will have an output of 640 tons per day of eight hours. The hoisting is therefore a considerable item. The old steam-hoisting plant has been discarded and an electrically driven gear installed in its place. This plant embodies the Ilgner principle, which has been used with considerable success on the Continent of Europe. One of the greatest difficulties in making an economical winding gear, whether steam or electric, is the enormous work done for a few moments in accelerating the cage at every lift. The plant must be capable of complying with these periodical demands for power, although the average work required of it is much less. In the Ilgner system the plant is proportioned to deal with the average work, and a heavy flywheel is used, which absorbs energy or restores it to the system, according as the work at that instant is less or greater than the average. In the Cobbinshaw plant the power is supplied by three-phase overhead mains brought across the moor from the powerhouse of the Pumpherston Oil Company at a pressure of 400 volts. The current is led to the stator of the induction motor of a flywheel motor-generator. This motor-generator consists of the induction motor and a continuous-current generator and a heavy flywheel, all mounted on the same shaft. To the slip rings of the induction motor are connected a resistance, which is automatically operated in such a manner that the greater the load upon the motor the greater will be the resistance inserted in the rotor circuit, so that the speed at which the induction motor tends to run is reduced as the load comes on, and the energy stored up in the flywheel is then utilized in driving the generator. Conversely, as the load decreases, the resistance is cut out of the rotor circuit, which then tends to run up to a higher speed and accelerate the flywheel, again storing up energy, which is utilized during the next wind. The generator of this unit is a continuous-current machine of continuous capacity equal to that of the induction motor, but it has been specially designed to withstand extreme overloads, as it must be able to commutate the current required at the peak of the winding load. In the case of this particular plant an overload of 400 per cent can be carried without sparking. This is secured by means of compensating windings in series with the armature, placed in slots in a special polar ring. They entirely neutralize the armature reaction at all loads. To accelerate the winding motor, resistance is cut out of the field circuit of the generator, thus increasing the strength of the field and thereby the voltage of the current supplied to the motor. Conversely, an electrical brake is applied to the winding gear by weakening the generator field, so that the winding motor becomes the generator and the generator of the motor-generator becomes a motor and accelerates the flywheel, thus storing up energy for the next wind. The winding engine is designed to lift a net load of twenty-five hundredweight. The maximum speed is twenty-three feet per second with an acceleration rate of two feet four inches per second. Thirty seconds are allowed for loading the car and twenty-five seconds for the complete lift. The flywheel weighs six tons and is a special Krupp steel casting which runs at 750 revolutions per minute synchronous speed. It is supported on special water-cooled bearings with forced lubrication. The balance is so good that no vibration whatever can be perceived when standing on the bedplate beside the wheel. The winding motor is a constantly excited machine and is direct-coupled to the winding drums, as gears are not advisable. It is of large size, since it runs at the low speed of ninety revolutions per minute. To control automatically the speed of the induction motor the three-phase current to this motor is led through the stator windings of a small induction motor, the armature of which, however, is not allowed to rotate. These currents, therefore, set up a torque in the rotor of the machine which tends to rotate it, but which is resisted by a balance weight. When the current exceeds a certain value the torque overcomes the counterweight and the rotor is allowed to turn and in this way rotates the brushes on a commutator type of controller, thus inserting resistances in the rotor of the main generator. The amount of the resistance inserted is proportional to the stator current. This arrangement is found to be more sensitive and reliable than a mechanical governor, which is usually employed on the Continent.—*Abstrated from Engineering (London), March 30.*

The International Association of Municipal Electricians.

The eleventh annual convention of the International Association of Municipal Electricians will be held at New Haven, Ct., August 15, 16 and 17. The following papers will be presented and discussed: "History of the Fire-Alarm and Police Telegraphs"; "Details of Certain Auxiliaries to Fire-Alarm Apparatus"; "Advisability of Protecting Municipal Electricians by the Civil Service Laws"; "Comparison of Underground and Overhead Wiring and of the Relative Values of Single Rubber-Covered Wire and Lead-Encased Cable for Underground Construction"; "Conditions Surrounding the Inspection of Wires in the Southwest."

In addition to this the question box will be a feature of this meeting.

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

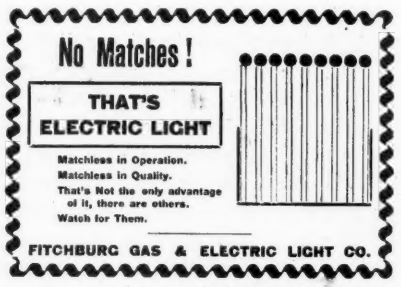
The point is made from time to time that it is only in communities where there are large numbers of consumers and where the sale of current reaches such proportions that the company can afford to do advertising on an extensive scale that publicity pays for itself. That this is a fallacy there seems to be no doubt, if we accept the testimony of those who have made a close study of this subject and have looked upon the matter without bias. Of course, it is the function of an advertising expert to assume that publicity will pay for itself, no matter what the local conditions. While this assumption may be selfish there is good ground for its realization in the very enthusiasm with which the advertising man generally takes up the problem.

Within the last six months we have reproduced a number of illustrations of advertising literature which has been prepared by the publicity departments of the larger corporations. While it must not be considered for a moment that the smaller central station is expected to undertake publicity on the same scale as the mighty corporation which can afford from $10,000 to $100,000 on its campaign of publicity, there are many instances where the work of the big corporation could be imitated with very good results.

The trouble with the publicity of the smaller central station in most cases comes from a misunderstanding of the possibilities of judicious advertising. It must not be assumed that an advertising department, once created, will burden the management with an expense which shows no direct return. There is hardly a piece of machinery—if for a moment we consider the department as such—which, once installed, will show quicker returns and eke out a better surplus for the boosting of the whole property. Statistics certainly seem to show that where modern methods of publicity have been properly applied the per capita sale of current is so much greater than where no effort is made to retain old consumers and secure new customers that where this condition is once demonstrated there is no doubt as to the feasibility and necessity of an advertising department.

It can be said, without any fear of controversy, that there is no central station which is so small, or there is no territory so limited, that the sale of the public utility can not be increased by a well-defined campaign on the part of the producer. There is hardly a community large enough to support an electric light plant which has not a local newspaper. This affords an excellent medium for reaching almost every one who could be interested in securing the advantages of electricity for lighting, heating and power. Again it must be assumed that where current is sold bills are rendered, and there is no reason to believe that the stickers employed by the large companies could not be used by the smaller company when sending out bills with equally good effect. Possibly it would take a long time to educate the people of some communities to the advantages of various forms of luxuries, but they will never become educated to the use of any new device unless it is constantly brought to their attention in some attractive form.

The case of the Miami Light, Heat and Power Company, operating in Piqua, Ohio, demonstrates the practicability of all that we have said. This company has begun the distribution of an electric light bulletin printed on an Edison rotary mimeograph. The announcement is made that the bulletin will be published monthly, semi-monthly and semi-occasionally. It will be devoted, in general, to the exploitation of electricity in its various applications. In the first bulletin issued the company calls attention to the improvements recently made in the manufacture of electric cooking and ironing devices. To introduce some of these devices the company advances the proposition to furnish any consumer with a six and one-half-pound electric flat-iron on thirty days' free trial. If at the end of the thirty days the consumer wishes to retain the use of the iron, the company will charge merely the wholesale cost price for it. The company also offers to send a representative to instruct the consumer in the use of the iron. This company maintains a window display which advertises the line of goods it carries. It also makes use of an advertising novelty in the form of an arc lamp frame with an opal closed base outer globe. Inside of this there are placed six colored globes—red, green and blue, each globe operating on a "Skeedoodle" socket plug. The combination of changing colors of the globe is bewildering and attracts a great deal of attention to the window display.



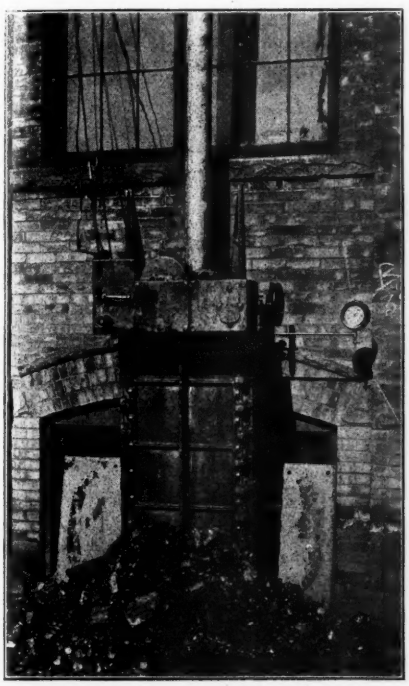
Anent the subject of newspaper advertising, we take a good deal of pleasure in reproducing herewith a number of advertisements which have recently been made effective use of by the Fitchburg (Mass.) Gas and Electric Light Company. It will be noticed that a good deal of original suggestion is contained in each of these advertisements. The arrangement of the display is simple in the extreme, plain Gothic and heavy rules being used exclusively. These advertisements have been employed consistently and persistently. Each calls attention to some consideration which affects, in greater or less degree, every reader of the paper in which the advertisement is placed. The smaller central stations can not do better than to follow in the lead of these progressive spirits who have had the courage to make an initial investment in an advertising department, and who are now realizing ample returns for their investment.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Official Tests of Electrically Operated Bulkhead Doors.

The introduction of power-operated bulkhead doors has led to the testing of the efficacy of this method of door closure in the case of a puncture involving a rush of water through the coal bunkers and the consequent closure of the doors through masses of coal. The United States Navy Department, through the Bureau of Construction and Repair, has recently conducted an elaborate test of the "Long Arm" system of power door. This door



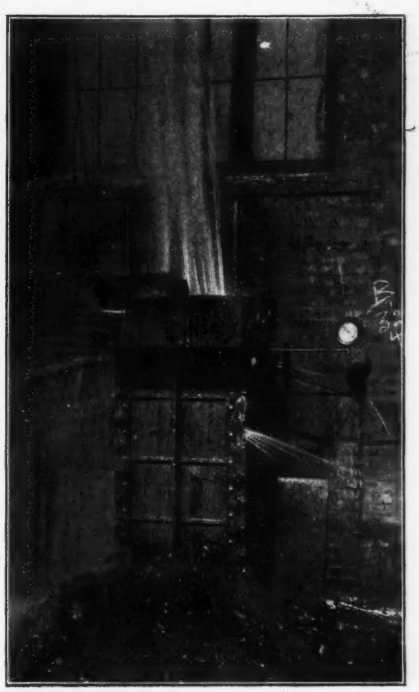
ELECTRICALLY OPERATED BULKHEAD DOOR CLOSING INTO COAL.

was selected for the experiments because this system is the only one installed on United States warships. The conditions existing on board ship when the coal bunkers are full and the doorways between the bunkers and the fire room are opened and chocked with coal were reproduced as closely as possible, the test including a reproduction of the situation which would arise in the event of a hull puncture, with its consequent inrush of water.

Before proceeding with the coal and water tests, the door was operated continuously for a period of several days, during which time it was opened and closed over 3,000 round trips. This was considered equivalent to ten years of actual service on a warship.

In carrying out the test the power door was secured to a steel box, which was intended to represent a coal bunker, and connected by a large pipe with a tank on the third floor of the building where the tests were conducted. At the lower end of this pipe there was located a valve for controlling the flow of water and a gauge for measuring the pressure in the box, which could, if desired, be continuously maintained at 15.2 pounds pressure per square inch, which is equivalent to a thirty-five-foot head of water above the sill of the door.

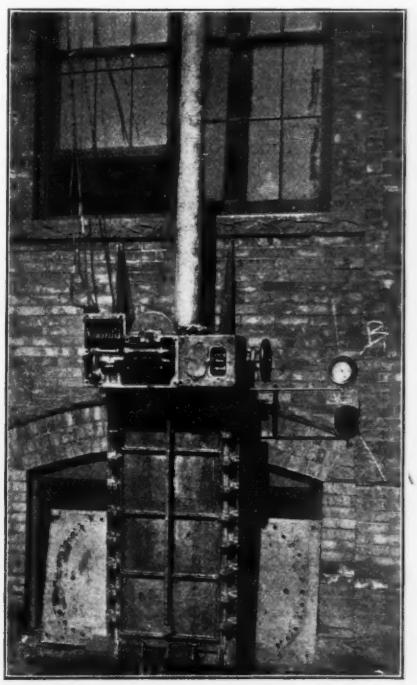
The box upon which the door was mounted was filled with coal, which was allowed to run through the door opening in the same way that it would if the door were opened from a full bunker. Large lumps of coal were mixed with the layers of all sizes. Before closing the door upon this mass of coal, fine coal dust was shoveled and thrown up all over the tighteners and the frame in order that the



ELECTRICALLY OPERATED BULKHEAD DOOR CLOSING INTO COAL WITH WATER UNDER HEAD OF THIRTY-FIVE FEET.

conditions of the test might be as severe as possible. To make the coal dust stick in sufficient quantity the bulkhead frame and tighteners were covered with thin oil.

The door was then closed from the bridge emergency station. The door plate cut through nearly all the coal, and the clear opening was practically completely closed when the automatic cutout opened the circuit and stopped the motor. After the door had closed into the coal by the electric emergency action and had been stopped by the automatic cutout, the water from the tank above was let in the box back of the door plate and a head of thirty-five feet above the sill was maintained. A thin film of spray worked its



ELECTRICALLY OPERATED BULKHEAD DOOR AFTER COMPLETE CLOSURE—WATER UNDER THIRTY-FIVE FEET HEAD.

way through the clearance space between the bulkhead frame and door plate, and in some cases the water succeeded in washing out the fine coal dust which had collected. At this time the actual leakage measured less than seventy-five gallons per minute. The water back of the door plate soon worked its way out through the coal at the bottom and washed away the pile of coal in front, thus relieving the resistance to the thrust of the door plate, causing the automatic cutout to throw in the current again and allowing the door to complete its closure.

The Rockwood Manufacturing Company, Indianapolis, Ind., is distributing a unique pulley computer.

Extensions to the West Allis Works of the Allis-Chalmers Company.

The new extensions to the West Allis (Wis.) works of the Allis-Chalmers Company, Milwaukee, Wis., which, when completed, will add 861,000 square feet to the plant's present floor area of 652,000 square feet and make the entire plant capable of affording employment to 11,000 persons, will place the West Allis works among the largest industrial plants of the country. The extended works, together with the capacities of the other works of the company in Milwaukee, Wis.; Chicago, Ill.; Cincinnati, Ohio, and Scranton, Pa., will be capable of affording employment to a total of approximately 18,000 persons. The work of constructing these extensions involves an expenditure of over $3,000,000. Two buildings—the extensions to the erecting shop and the pattern shop—have been practically completed, while substantial progress has been made on the remaining buildings. The West Allis site, situated in the town of West Allis, on the outskirts of Milwaukee, has a frontage of 1,575 feet and runs back 2,696 feet, giving a ground space of about 100 acres, adjoining the tracks of the Chicago, Milwaukee & St. Paul Railway.

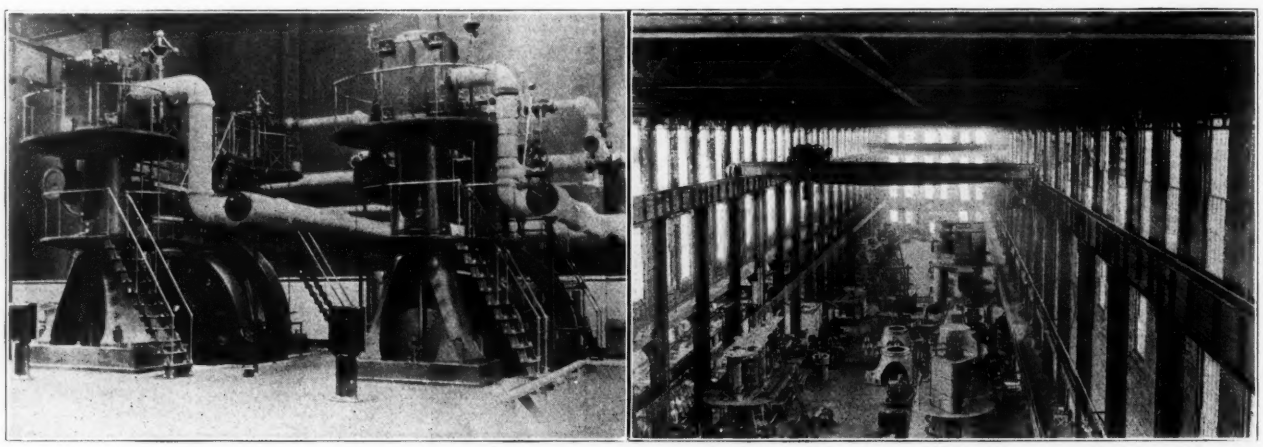
The general plant of the West Allis works provides for two sets of building units, one composed of those in which the work is common to every class of product, like the pattern shops, erecting shops and foundry; the other group comprising the machine shop units, where the work is specialized for various machine operations. The two groups of buildings lie at right angles to each other; those of general utility lengthwise of the plot north and south. The machine shops, six units in all, run crosswise of the plot, adjoining the erecting shop at the east end. Facing the ends of the machine shop units No. 1 to No. 6 stands the foundry with its extensions, extending north and south. The pattern storage and shops stand farthest westward in the group, parallel to the foundry, with a span of ninety-eight feet between them.

The existing power-house occupies about a third of unit No. 3 at the west end and adjoining the blacksmith shop. The engine room at the present time holds an equipment of three Allis-Chalmers engines, as follows: one Reynolds vertical cross-compound, direct-coupled to a 550-kilowatt, 250-volt, direct-current generator; an engine of similar type direct-coupled to a 300-kilowatt, 250-volt, direct-current generator, and a Reynolds vertical engine direct-connected to a 100-kilowatt, 250-volt, direct-current generator, together with a horizontal two-cylinder, tandem Nurnberg gas engine of the four-cycle, double-acting type, driving a 150-kilowatt, direct-connected, direct-current generator. There is also a cross-compound, two-stage Allis-Chalmers air compressor with a capacity of 1,000 feet of free air per minute, supplying air at a pressure of 100 pounds to the inch for use in pneumatic tools and air hoists in the works and for air lifts in the artesian wells. The new equipment for furnishing power to the works extension consists of a Reynolds vertical cross-compound engine direct-connected to a 6,000-kilowatt Bullock direct-current generator, and an Allis-Chalmers cross-compound air compressor, with the air cylinder eighteen inches by thirty inches, the steam cylinders eighteen by thirty inches and a forty-two-inch stroke. In the boiler house five Edgemoor tube boilers with a total aggregate horse-power of 3,293 and a heating surface of 6,586 square feet each will replace five Reynolds ninety-six-inch vertical tubular boilers aggregating 876 horse-power, which will be installed at the Reliance works. The new boilers will be operated in connection with Jones under-feed stokers. A stack 175 feet high and eight feet inside diameter furnishes natural draught.

New machine tools involving an expenditure of $500,000 will be installed in the machine shop. The combined weight of these tools, with the motors used for driving them, aggregates 2,141 tons. Fourteen of the new machines are vertical-boring and turning mills, from eight to sixteen feet and extra heavy in design. There are five standard shaft lathes and two crank-shaft lathes with a swing of from sixty to 125 inches and thirty feet between centres; eight planers of various sizes, all of which are of the spiral-geared type; a 260-ton armature press, and several drilling and boring machines, slotters, etc. Over 1,200 horse-power in Allis-Chalmers motors will be required to drive the new equipment.

Direct current at 250 volts is distributed throughout the building for the operation of motors used for machine tool drive. These motors are largely operated on the Ward Leonard multiple-voltage five-wire system (Bullock system of control for variable-speed motors), making twenty-seven different speeds possible for each machine.

The heating system utilizes exhaust steam passed through a closed heater corresponding to the primary heater in a condensing system. An auxiliary live-steam heater is provided to operate in connection with the exhaust-steam heater for cold weather. The hot water thus obtained is circulated through the works by means of two centrifugal pumps electrically driven. The total space to be heated is 26,000,000 cubic feet, traversed by 500,000 feet of one and one-half-inch hot-water pipes.

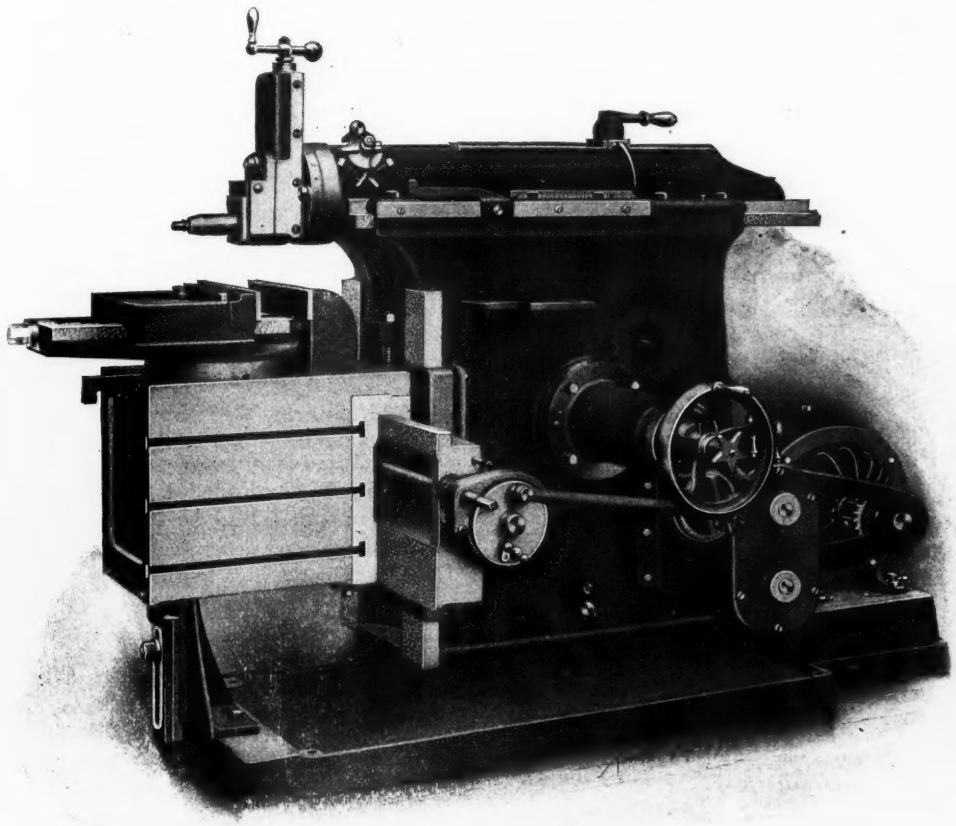


VIEWS IN POWER STATION AND ERECTING SHOP, WEST ALLIS WORKS, ALLIS-CHALMERS COMPANY, MILWAUKEE, WIS.

"American" Motor-Driven Shaper.

The accompanying illustration shows an electric motor-driven shaper designed and built by the American Tool Works Company, Cincinnati, Ohio.

The drive "S" shown consists of a constant-speed motor mounted on a substantial base at the rear, and is connected by spur-gearing to the driving shaft of the four-speed box, which provides the usual speeds for the ram. The starting box for the motor may be placed on the side of the column within easy reach. An index plate shows how to secure the various speeds.



Motor-Driven Heavy-Duty Shaper.

The speed box is mounted on the column, in the place of the cone pulley, and provides four mechanical speed changes through the manipulation of two convenient levers thereon. The four speeds are obtained with six gears, which are of steel and bronze. The manufacturers are prepared to furnish this speed box with pulley for belt drive from countershaft.

Another method, drive "T," consists of connecting a variable-speed motor direct to the driving shaft of machine through spur-gearing. The variations of speed are then secured through the motor.

The shaper is of new design throughout, is exceptionally heavy and adapted to the most severe duty. The stroke is changed and positioned without stopping the machine. The feeds are positive, with a very wide range. The sliding bearings are large and supplied with continuous taper gibs for taking up the wear. The running bearings are bushed to provide for wear, and the key seating capacity is large. The vise is heavy, with steel-faced jaws, and has a bearing almost covering the entire top of table. All regular shaper attachments can be furnished.

Tri-City Consolidation.

There has occurred recently a reorganization of the public service utilities of a manufacturing centre in the Middle West which indicates an interesting trend of industrial development. While Wall street has been the centre in which most big engineering enterprises of the country have been financed, a concentration of engineering control in the same locality marks an epoch.

The engineering firm of J. G. White & Company is associated with the banking houses of Mackay & Company and Halsey & Company in plans involving $21,000,000 for the institution of a thoroughly modern service in connection with the traction, light and power utilities of the "Tri-cities"—Rock Island, Moline and Davenport.

There is in this locality at the present time a heterogeneous collection of eight separate companies supplying light, power and transportation for about 100,000 inhabitants. These are the Tri-City Railway Company, operating a railway in Davenport, Rock Island and Moline; the People's Light Company, doing a gas and electric light business in the city of Davenport; the People's Power Company, doing a gas and electric power business in Moline and Rock Island; the Davenport & Suburban Railway, between Davenport and Grand Island; the Davenport Gas and Electric Company, a direct competitor of the People's Light Company; the Mississippi Valley Traction Company, operating an electric railway between Moline and Watertown, and the Moline Water Power Company, which controls the Mississippi river water power developments in the district.

The report of the physical condition of the properties of these companies was made for the bankers by J. G. White & Company, and it is probable that the operating department of the same company will be charged with the work of operating the consolidated system in accordance with the best modern practice, one of the foremost operating experts of the country being made general manager of the holding company, which will be known as the Tri-City Railway and Light Company.

In the traction system there are 100 miles of track, and one phase of the general improvement contemplated is the renovation of the service of the street railways, involving more frequent and regular service and an increase of speed. Another step in the direction of increased efficiency will be the manufacture of a single variety of gas in one plant instead of the manufacture of six varieties in three different plants, as now obtains. Finally, the water power rights of the Moline Water Power Company will be made the most of and so developed as to permit the

abandonment of a large percentage of power generation by steam.

The "Tri-cities" are the nucleus of important manufacturing districts. Moline contains the most important plow manufactories in the world. On an island in the Mississippi river, opposite Rock Island, is located the Rock Island arsenal of the government, valued at $15,000,000, comprising forty acres of floor space and employing 3,000 operatives. While this arsenal has been devoted chiefly to the manufacture of munitions of war, it is planned to inaugurate here the manufacture of small arms for the service. In Rock Island proper are located the main shops of the Rock Island Railroad system. There are innumerable industries of lesser magnitude in the district, so that altogether there is a high percentage of the thrifty industrial class.

Separating Oil from the Exhaust.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

We were much interested in reading the description of the Pennsylvania Railroad Company's Long Island City power station which appeared in your issue of April 7. There is in this article, however, one point to which we take serious exception. We quote from the last few lines in the third column on page 536: "the Westinghouse single-acting engines driving auxiliary machinery do not send their exhaust steam to this heater on account of particles of crank-case oil that may work into the exhaust."

While the engineers of this plant may not believe that the crank-case oil can be removed from the exhaust steam by an oil separator, and while it may be true that many makes of oil separators are not efficient enough to remove this oil, it is a positive fact that the Cochrane oil separator, when installed to meet these conditions, will remove this oil. The exhaust steam from the Westinghouse single-acting engine in our own plant has for years been passed through a Cochrane oil separator into a Cochrane feed-water heater from which our boilers are fed, and we have absolutely no trouble from oil in the boilers. We could give you the names of a number of other plants in which Cochrane oil separators give thoroughly satisfactory and successful service in taking the oil out of exhaust steam from Westinghouse engines.

HARRISON SAFETY BOILER WORKS,
R. H. Ramsey.

Philadelphia, Pa., April 14.

Disastrous Earthquake in San Francisco, Cal.

At five o'clock on the morning of April 18 an earthquake was visited upon San Francisco, Cal., the Western Union Telegraph and the Postal Telegraph companies wires, and also those of the electric light and telephone companies, being prostrated. A number of buildings were demolished and set on fire and many lives have been lost.

A High Potential Insulating Compound.

In bringing out its new insulating compound, Voltax, the Electric Cable Company, of 17 Battery place, New York, has placed upon the market what it believes to be one of the best high-potential insulating materials ever devised for wires and cables. This belief seems to be confirmed by the accompanying reports made on Voltax by a leading electrical testing laboratory of New York, where there were carried out a large number of careful tests at the request of the manufacturer. One of the most important points brought out was the neutral character of this material, which, of course, gives it special advantages over rubber as an insulating material in that it is not affected by the chemical character of the media with which it may come in contact nor does the wire need tinning to avoid corrosion. Another valuable feature of Voltax is its ability to withstand temperatures as high as 250 degrees Fahrenheit without melting.

The tests made on the four samples of wire submitted brought out the high potential and insulating resistance of Voltax in addition to the melting point and carrying capacity as determined by the dripping of the insulation. It is worth noting that the results mentioned below were all obtained from hand-taped wires and that even better figures would have been secured if the more uniform machine-taped wires had been submitted. For the insulation resistance trials the largest number of tapes was only six.

For all of these tests one or more 10,000-volt, one-half-kilowatt transformers (placed in series) were employed, the pressure being gradually raised until puncture occurred. This pressure was applied to the samples between the copper and the tin foil wrapped tightly around it. Another set of tests was made on thin Voltax sheets by placing each between one-inch discs connected to the high-potential terminals of the transformers.

In the following table I are given the puncture voltages of three samples of taped wire impregnated with Voltax. The samples are numbered according to layers:

TABLE I.

Sample.		Volts at Puncture.	Average of Tests.
No. 1	Highest	7,500	4,390
	Lowest	2,500	
No. 2	Highest	10,500	8,300
	Lowest	4,000	
No. 4	Highest	27,900	27,750
	Lowest	27,600	

After a trial of their carrying capacity high-potential tests were made of two wires as detailed in the following table II.

TABLE II.

Sample.		Volts at Puncture.	Average Volts.
One tape	Highest	2,100	2,050
	Lowest	2,000	
Four tapes.	Highest	27,600	27,750
	Lowest	27,900	

By comparing the figures given in tables I and II for the puncture voltages it will be noted that they proved the same despite the carrying capacity tests.

In table III will be found a summary of the trials of the Voltax compound prepared in sheets.

TABLE III.

Sheets.		Volts at Puncture.	Thickness.	Volts per Mil.
No. 1	Lowest	20,000	75 mils.	267
	Highest	25,500	75 mils.	344
No. 2		22,500*		
No. 3		30,000	105 mils.	286
No. 4		30,000		

*Arced over edges but did not puncture.

Referring to table III it may be added that sheet No. 3 withstood 30,000 volts for ten seconds, while No. 4 withstood the same potential for one minute without puncture.

The insulation resistance tests were made on a copper wire covered with six layers of tape impregnated with Voltax and then placed in salt water. After several periods of immersion the galvanometer method was applied. As the resistance was found to be in thousands of megohms exact determination was impossible. Similar high resistances were found in testing the prepared sheets.

Opening of the Electrical Club.

The Electrical Club, of New York city, will open its doors to its members and invited guests on Saturday, April 21, at its clubrooms on the third floor, 14-16 Park place. The reception will continue from 2 to 4 P. M.

These clubrooms occupy the entire third floor of the building and are very conveniently arranged for the purposes of the club, which are to provide downtown lunching facilities for the electrical fraternity. The officers of the club are Mr. J. P. Hall, president; Mr. H. L. Shippy, vice-president; Mr. Charles P. Scott, treasurer, and Mr. R. B. Corey, secretary. The club begins its career with a very excellent list of 150 members.

New York Electrical Society.

A highly entertaining lecture will be given to the New York Electrical Society at the Edison auditorium, 44 West Twenty-seventh street, Wednesday, April 25, by Mr. Melville E. Stone, general manager of the Associated Press, on "Newspapers and the Telegraphic Art."

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW TELEPHONE ENTERPRISE—The Illinois Manufacturers' Association has decided to incorporate a $9,000,000 telephone company which can be equipped within two years. The 900 members of the association are to subscribe. The rates offered the city include three-cent public calls, and are from ten to thirty per cent below the prices set by the Chicago Telephone Company in its last reduction.

MEXICAN TRAMWAY COMPANY—The Mexican Tramway Company, which has been formed by Canadian capitalists to take over the tramway lines of the state of Mexico from Messrs. Wehrner, Beit & Company, is offering $8,000,000 bonds at ninety with thirty-five per cent bonus stock. The entire amount was first underwritten by a syndicate, most of the members of which are directors of the Mexican Light and Power Company.

CHICAGO IN TEN HOURS BY PROPOSED AIR LINE—Ten-hour trains between Chicago and New York, making an average speed of seventy-five miles an hour, are planned by the incorporators of the Chicago & New York Electric Air Line Railroad. Mr Jonathan D. Price, president of the Cooperative Construction Company, which will build the road, is quoted as stating that the line will be 742 miles long, and that everything will be sacrificed to speed.

IMPORTANT WESTERN TELEPHONE DEAL—It is understood that the details have been completed for the sale of the properties of the Federal Telephone Company, of Cleveland, Ohio, and all of its subsidiary companies to James S. Brailey, of Toledo, Ohio. In addition to the independent properties throughout northern Ohio, this sale will include the controlling interest in the United States Long-Distance Telephone Company and the Cuyahoga Telephone Company, of Cleveland, Ohio.

ELECTRICITY TAKING THE PLACE OF STEAM IN LAKE MINES—The use of electricity as a motive power at the Lake Superior copper mines is rapidly increasing. Within a short time all of the rockhouses of the Calumet & Hecla Mining Company's Calumet glomerate, Kearsage & Osceola amygdaloid mines will be equipped with motors, and electricity will supplant steam as a motive power in the operation of the machinery in these buildings. Preparations for the introduction of electrical power in the carpenter and blacksmith shops of the Calumet & Hecla mines are practically completed. Eventually electric power will be used for hoisting at many of the shafts, and this use will be extended as conditions permit.

REDONDO (CAL.) POWER PLANT—Within sixty days work will be started on an extensive power plant at Redondo, Cal. This will be a steam plant, and will be owned and operated by Henry E. Huntington, the Pacific Light and Power Company and C. C. Moore & Company. The plant will supply power principally to the Los Angeles Railway. It is to be completed in a year, and the present power-house of the electric line at Sixth street and Central avenue, Los Angeles, will be abandoned. The new plant complete will cost $1,250,000. The capacity will be 25,000 horse-power. The buildings will be of brick and steel, the engine house seventy feet by 165 feet, the boiler house 145 feet by 122 feet, with two concrete chimneys 125 feet high and thirteen feet in diameter at the largest point.

THE NORFOLK & PORTSMOUTH TRACTION COMPANY—As was indicated last week, the name of the new company which absorbs the electric traction and lighting properties in the vicinity of Norfolk, Va., is to be the Norfolk & Portsmouth Traction Company. The capitalization is $6,000,000 stock and $8,000,000 bonds. There will be an immediate issue of $3,500,000 bonds and $5,000,000 of stock. R. L. Williams, president of the Norfolk Railway and Lighting Company, which owns the largest properties absorbed, is to be the president of the new company. An interurban line from Portsmouth to Suffolk and Smithfield, Va., will be built, and new lines extended to the Jamestown Exposition grounds. Mr. E. C. Hathaway, general manager of the Norfolk Railway and Lighting Company, is to be general manager.

CINCINNATI GAS AND ELECTRIC COMPANY—The directors of the Cincinnati Gas and Electric Company have decided to lease the company to an eastern company headed by Archibald S. White and other financiers associated with the Windsor Trust Company, of New York. This syndicate will take the property under a guarantee of dividends of four and one-half per cent for two years, four and three-quarter per cent for two years and five per cent thereafter. The syndicate also agrees to expend $2,000,000 on improvements, and to pay $3,000,000 in cash as a guarantee fund. There will be a holding company with $20,000,000 capital, half of which will be six per cent guaranteed preferred stock. The new company will probably be called the Consolidated Gas and Electric Company. The syndicate will take over the Cincinnati company on July 1, and the stockholders will meet very soon to ratify the action of the directors.

FOR AN AIR LINE TO BOSTON—President Mellen, of the New York, New Haven & Hartford Railroad, is credited with the following statement, in answer to an enquiry as to the effect the construction of an independent air line electric road from Boston to New York city would have on the present plans of the New Haven road: "the revision of the Boston and New York air line from New Haven and Willimantic to Boston will make a line approximately 200 miles in length between New York and Boston, upon which trains can be easily run in four hours by steam and in less time by electricity, and at as low a fare as upon any other road in existence or proposed or even theorized about. Such a line the New Haven management has in contemplation. The engineers are now at work upon it, the financing of the same has been provided for, and the line itself will be available for use before a charter even can be obtained for such a line as has been petitioned for before the Massachusetts legislature."

OBITUARY NOTICES.

MR. NATHANIEL SOUTHGATE SHALER, dean of the Lawrence Scientific School, Harvard University, died on April 10 at Cambridge, Mass. He was born in Kentucky sixty-five years ago. In 1859 he was graduated from Harvard. During the war he served as a captain in Shaler's battery, a Union organization. After the war he returned to Harvard, taking up work as a teacher, and was rapidly advanced to a full professorship. Fifteen years ago he was made dean of the school. It was due to his efforts that the McKay bequest of $5,000,000 was made to the institution a few years ago. He was one of the foremost geologists in the country, and since 1884 had been in charge of the Atlantic division of the United States Geological Survey. He had written many treatises and text-books on this subject.

MR. LEMUEL BANNISTER, for many years vice-president of the Westinghouse Electric and Manufacturing Company, died on Friday, April 13, at the Hotel Imperial, New York city, after an illness of several months. Mr. Bannister was born in a small town in northern New York in 1841. He was educated in the public schools. His first business ventures were in the lumber trade, and for many years he was connected with R. D. Wood in that business in Philadelphia. He then went into the electrical business, becoming connected with the Westinghouse company. He was vice-president of the New York house, and practically at the head of the European business, to take charge of which he left America ten years ago. He built electric railways in Berlin and other European cities. For a time he was in charge of the Pittsburg house. He was a member of the Lawyers' and Engineers' clubs, of New York city, and the Duquesne Club, of Pittsburg. Eight months ago Mr. Bannister was taken ill, and, becoming worse, came to New York two weeks ago. His wife, Frances Kenyon Bannister, survives him.

NEW INCORPORATIONS.

DETROIT, MICH.—Fenton Light and Power Company. $50,000.

ELGIN, ILL.—Elgin & Belvidere Electric Railroad. Increased from $2,500 to $1,200,000.

COLUMBUS, GA.—Columbus Power Company. $1,850,000, with the privilege of increasing to $3,000,000.

COLUMBUS, OHIO—Cincinnati Gas and Electric Company. Increased from $31,000,000 to $36,000,000.

NASHVILLE, TENN.—Citizens' Gas Light Company, of Madison county. Increased from $50,000 to $200,000.

COLUMBUS, OHIO—Covington Home Telephone Company, Covington. Reduction of capital from $30,000 to $23,000.

AUGUSTA, ME.—Lake View Traction Company. $50,000. Officers: president and treasurer, I. L. Fairbanks, of Augusta.

COLUMBUS, OHIO—The Interurban Railway Company, of Cincinnati. To operate a line from Lebanon to Morrow. $5,000.

DENVER, COL.—The Goodland Light and Power Company. $50,000. Incorporators: Henry Hanington, William H. Frazier and E. J. McLean.

AUGUSTA, ME.—Dixfield Light and Water Company. $50,000. President, J. A. Decker; treasurer, J. B. Johnston; clerk, G. L. Merrill, all of Dixfield, Mass.

SPRINGFIELD, ILL.—People's Telephone Company, of southern Illinois, Rinard. $10,000. Incorporators: J. W. Zimmerman, William Hunt and Isaac Smith.

CAMDEN, N. J.—Santa Cruz Mercantile Company. To sell and dispose of electric light and gas plants. $625,000. Incorporators: Frank Adams, M. L. Wilson, Charles Bridge.

HELENA, MONT.—East Fork Telephone Company. $6,000. Directors: A. V. Rogers, J. D. Clark, S. F. Bowman, of Rogers, and J. W. Miller and Walter C. Downing, of Lewistown.

INDIANAPOLIS, IND.—South Side Telephone Company, of Lockman. $2,000. Directors: James C. McKinney, Charles W. Spurgeon, Carl Carmichael, Daniel B. Eddy and George W. Treux.

GUTHRIE, OKLA.—Shawnee Gas and Electric Company, of Shawnee. $750,000. Incorporators: F. B. Stearn, of Shawnee; T. W. Odell, of Oshkosh, Wis.; Sinclair Mainland, of Green Bay, Wis.

MADISON, WIS.—Tamarac Telephone Company, Arcadia, Trempealeu county. $3,000. Incorporators: Sam Strand, Carl Gilbertson, Albert Syverson, Ole A. Olson, Alick Olson and Thomas Thompson.

COLUMBUS, OHIO—The Sandy Valley Traction Company, of Canton, Ohio. $8,000. Incorporators: W. Pennock, S. S. Denford, D. S. Ibray, J. S. Spring, W. W. Shindler, G. D. Franch and M. J. McGinty.

SAN ANTONIO, TEX.—Ladonia Light and Water Company, of Ladonia. $30,000. Incorporators: Sam Prim and Will Haskins, of Ladonia; C. W. Alley, Sam J. Hogsett and August J. Gilliott, of Dallas.

FREMONT, MICH.—The Cooperative Construction Company. To promote and build an electric railroad from Grand Rapids to Ludington *via* Hesperia, Hart and Pentwater, and probably Wakerville. $10,000.

ALBANY, N. Y.—Willow Point Telephone Company. $500. Directors: Frederick A. Pierce, Lee M. Winans and Isaac S. Mosher, of Vestal, and Charles Golden, Stephen Nooseickle, Elbert W. Willis and Orrin J. White, of Willow Point.

HARRISBURG, PA.—New Bedford Telephone Company, New Bedford. To operate telephone and telegraph lines for private use of individuals, firms and corporations in the counties of Mercer and Lawrence, Pennsylvania; Mahoning and Trumbull counties, Ohio; reaching New Castle, New Wilmington, Pulaski, West Middlesex, Edinburg, Hillsville, Lowellville, Struthers, Youngstown and other villages, boroughs and cities. $5,000. Directors: S. M. Porter, Pulaski; W. S. Lowry, New Bedford; E. A. Toby, New Bedford; J. A. Brown, Pulaski; W. W. Brownlee, Louisville; E. K. Cover, Pulaski; Ellis Smith, Lowellville.

TELEPHONE AND TELEGRAPH.

TOLEDO, IOWA—A new telephone switchboard will be installed.

HOMER, N. Y.—A movement is on foot to organize a telephone company in Truxton and Cuyler.

MARATHON, N. Y.—A company has been organized to put a telephone line through east from Marathon to Freetown.

WALLERVILLE, TENN.—It is stated that the Cumberland Telephone Company will build a line from Wallerville to Pontotoc or Ecru in the near future.

FARGO, N. D.—The La Moure County Telephone Company at its annual meeting at Marion elected A. W. Cunningham president This company built fifty miles of new line during 1905.

NEW CASTLE, DEL.—The Delaware & Atlantic Telegraph and Telephone Company, which has its headquarters in Wilmington, is to place its New Castle wires underground.

ELMIRA, N. Y.—The farmers in the vicinity of Corry have organized a telephone company which will take in a number of farms and connect with the Bell exchange in Corry.

MADISONVILLE, TEX.—The Madisonville Telephone Company is again making extensive improvements to the local system. Two new 100-drop switchboards have been ordered, and also a power generator.

JOHNSONBURG, PA.—The Elk Telephone Company has begun the construction of about fifteen miles of additional line, which will give subscribers connection with Rasselas, Glen Hazel, Straight, Instanter and Clermont.

ADAIRVILLE, KY.—A new corporation, to be known as the Red River Telephone Company, has been organized by T. H. Baird, J. D. Ryan and W. R. Smith, and proposes to operate under the franchise recently sold to W. K. Smith.

CHICAGO, ILL.—The Coles County Telephone Company, recently incorporated with $100,000 capital, has absorbed the Mattoon Telephone Company, the Coles County Telephone Company and the Charleston Telephone Company.

JACKSON, MICH.—The Michigan State Telephone Company has commenced making improvements on the Buell-Cook telephone property at Rives Junction, which it recently acquired. Three toll lines now centre in the Rives switchboard.

PRESCOTT, WIS.—A local telephone company has been organized in Pierce county. The incorporators are A. Combacker, J. E. Foley, N. N. Buck, W. P. Knowles, F. A. Severance and J. T. Biddall. Lines will be extended to various villages throughout Pierce county.

ALBUQUERQUE, N. M.—General Manager C. W. Hinchcliffe, of the Consolidated Telephone, Telegraph and Electric Company, has announced that complete new automatic systems have been ordered for both Tucson and Phœnix. The improvements will cost $10,000 for each city.

WILMINGTON, DEL.—On account of an increase in business the Delmarvia Telephone Company has secured an entire building on Sixth street. There will be apparatus for 1,000 telephones in the building, enabling the company to improve considerably its service in the western part of the city.

HAVERHILL, MASS.—The incorporators of the People's Telephone Company, of New Hampshire have organized as follows: president, Warren Brown, of Hampton Falls; vice-president, Ernest Luce, of Boston; treasurer, Joseph G. Morgan, of Boston; clerk, Judge Henry A. Shute, of Exeter; directors, Warren Brown, Warren M. Batchelder, of Hampton; Daniel J. Bakie, of Kingston; George A. Carlisle, of Exeter; George B. Shaw, of Exeter; Joseph G. Morgan, Judge Shute and Ernest Luce.

OMAHA, NEB.—The Union Pacific and Southern Pacific will construct an independent long-distance telephone line from Omaha to San Francisco, and 2,000 telephones have been ordered for the equipment. The wire will be of copper, and a metallic circuit will be maintained. A separate line of poles will be used, and the telephones will have no connection with the telegraph line along the way. The telephone system will be used by trainmen and officials, and telephones will be put in every blind siding as well as in every town. The main line will be 1,800 miles long. Railroad offi-

cials believe that commercial business will be accepted on the new system.

TRAER, IOWA—The Toledo toll line has been sold and will be rebuilt.

RINGSTED, IOWA—The Farmers' Mutual Telephone Company will build rural lines.

HUNTINGTON, W. VA.—The Mutual Telephone Company will greatly improve its plant.

SALT LAKE CITY, UTAH—The Rocky Mountain Telephone Company is making extensive improvements in Lehi.

ATTLEBORO, MASS.—The American Telephone and Telegraph Company has been granted a franchise to place its wires underground.

NEW YORK, N. Y.—The Southwestern Telegraph and Telephone Company, operating in Arkansas and Texas, has increased its capital to $20,000,000.

BURLINGTON, IOWA—The Mississippi Valley Telephone Company will erect towers on each side of the Mississippi river and string wires across.

HORNELLSVILLE, N. Y.—E. Y. Butler has been awarded the contract for erecting the $20,000 building of the New York & Pennsylvania Telegraph Company.

WEST CHESTER, PA.—The Delaware and Atlantic Telephone Company is extending a line to the country beyond Green Hill, including Everhart and Kirkland.

HELENA, OKLA.—The Carwile Telephone Company has been incorporated by Nathan H. Ross, Fred J. Droite, of Aline, Okla., and Charles F. Gardiner, of Ringwood, Okla.

ELYRIA, OHIO—A telephone system will be established at Henrietta. Over $2,000 worth of stock has been subscribed. The new organization will start with sixty telephones.

LIMA, OHIO—The Central Union Telephone Company has purchased a tract of ground, and will erect a handsome operating and executive building. Plans for the building are being drawn.

WHITE PLAINS, N. Y.—Announcement has been made by the New York Telephone Company of a general reduction of telephone rates in Westchester county, to go into effect not later than June 1.

CINCINNATI, OHIO—The Cincinnati & Suburban Telephone Company, according to its new directory, has 32,000 subscribers. This is an increase of several thousand as compared with last December.

COLUMBUS, OHIO—The Flatrock Telephone Company will be reorganized and will continue to operate as an independent company. The new officers are John Gant, president, and Thomas Wooley, secretary-treasurer.

BIRMINGHAM, ALA.—The contract for the erection of the new exchange building for the Southern Bell Telephone Company, has been let to A. J. Krebs, of Birmingham, whose bid was $66,000. The structure will be five stories high.

STEUBENVILLE, OHIO—The National Telephone Company, of Wheeling, has closed a deal by which it absorbs the Phœnix Telephone Company, of Steubenville. The local plant was capitalized at $50,000, $42,000 of which was issued, and the stock was taken at par. An entirely new plant will be installed.

KERKHOVEN, MINN.—At the annual meeting of the Mamre & Pillsbury Telephone Company officers for the ensuing year were elected as follows: president, Louis Lofven; vice-president, G. Brobeag; secretary, Hjelmer Johnson; treasurer, J. Noland; directors, Joseph Holmgren, Theo. Johnson and J. A. Enander.

SPOKANE, WASH.—The Pacific States Telephone and Telegraph Company plans to spend $500,000 in extending and improving its system in the Spokane country, with the idea of securing greater business among the farmers of the Inland Empire. C. W. Reynolds, manager of the company, says that 3,000 telephones have been installed in these districts recently.

TONOPAH, NEV.—The Southern Nevada Telephone and Telegraph Company, owning nearly every important telephone line running into Tonopah and Goldfield, has taken over the lines of the Nevada Power, Mining and Milling Company, extending from Bishop, Cal., to Tonopah. The lines reach the following camps: Laws, Palmetto, Silver Peak, Lookout, Roberts and Oasis.

CANANDAIGUA, N. Y.—The People's Line Telephone Company, a local concern which was originally designed to furnish service to the territory between Canandaigua and Naples, will make extensions from Hemlock to Livonia Station, from Bristol Valley to Academy and Bristol Springs, and from Bristol Center to West Hill. This company will then cover the whole of western Ontario county.

FARMINGTON, N. H.—The People's Telephone Company has been organized. The incorporators are Warren Brown, of Hampton Falls; Warren M. Batchelder, of Hampton; George A. Carlisle and Augustus Young, of Exeter, and Daniel J. Bakie, of Kingston. This company will construct an independent line in Exeter and surrounding towns, and franchises already have been secured in Exeter, Kensington, East Kingston, Kingston and Hampton Falls. It is understood that the work of construction will soon begin.

DELL RAPIDS, S. D.—Preparations are being made to extend the lines of the Dell Rapids Telephone Company to all parts of the farming region tributary to Dell Rapids, as well as to every nearby town. The lines of the company already extend in several directions, and arrangements have now been perfected to make connections with the Colton and Jasper lines and the rural lines operated in connection therewith. Steps also are being taken to have the lines of the local company connected with the Trent, Baltic and Colman lines.

BALTIMORE, MD.—The Northern Central Railway is now establishing private telephone lines which will extend from Baltimore to Elmira. Part of the line has already been built. There are stations at Cockeysville, Md., York, Falls View, Lamoyne and Harrisburg, Pa. Stations will be placed at Marysville, Dauphin, Montandon, Milton, Williamsport, Pa., and other points north. York will be the exchange station. The equipment will greatly facilitate the handling of freight and will do away with much telegraphing and correspondence.

UTICA, N. Y.—The new telephone plant of the Central New York Telephone and Telegraph Company at Camden, which has been in the course of construction for some time, is nearly completed. It is modern in its equipment and will accommodate 500 subscribers. A good deal of work in the way of constructing rural lines will be done by the Bell company east of Utica, particularly in the vicinity of Little Falls and Herkimer. Seventy miles of rural lines were built about Little Falls last year, and over seventy miles will be built this year.

IOWA FALLS, IOWA—The telephone exchange heretofore operated by Bruening & Symington, has been sold to a stock company, in which the citizens of Iowa Falls, Des Moines, Waterloo and other places are interested. The new company is incorporated for $10,000, of which $6,000 is paid up, this being understood as the purchase price of the plant. E. B. Smith, of Waterloo, is president of the new company; G. E. McFarland, of Des Moines, vice-president; F. J. Martin, of Ackley, secretary, and H. A. Miller, of the same place, treasurer. These officers, together with Fred Cleaver, manager of the Iowa Telephone Company, at Iowa Falls, and C. E. Hull, and E. H. Haymond, make up the board of directors.

OKLAHOMA, OKLA.—The Pioneer Telephone Company is spending thousands of dollars in the improvement of its system, including extensions of existing lines, the installation of new exchanges and the betterment of service in a number of towns. A new exchange is being built at Perry at an expense of $15,000. A metallic circuit is being built between Pawhuska and Arkansas City, along the right of way of the Midland Valley railroad, thus giving service to towns between these two points. Recently the company was granted a franchise for an exchange at Cashion and work will begin as soon as the poles are received. An exchange will also be built at Kildare. All the material has been ordered for the rebuilding and the changing of the Waukomis system from automatic to manual. Exchanges will be built at Bokosche, Kildare, Ida Bell, Ravia, Webber Falls and Copan, I. T. The improvements at Shawnee have recently been completed at a cost of $50,000. The Pioneer company has purchased the plant of the Haskell Telephone Company, at Haskell, I. T., and will hereafter operate the system.

ELECTRIC LIGHTING.

GRISWOLD, IOWA—A new electric light plant is projected.

LOUISVILLE, KY.—Leitchfield is to have an electric light plant.

MEMPHIS, MO.—Electric lights are to be installed at Wyaconda.

BLACKWOOD, N. J.—An electric light plant is being installed at Blackwood.

MINNEAPOLIS, MINN.—Ellendale has raised $12,000 toward a lighting plant.

ALBIA, IOWA—A. R. Jackson has been voted a franchise for a heat, light and power plant.

LAPEER, MICH.—The council at a special meeting granted an electric light and power franchise to Frank J. Schlegel.

LOUISVILLE, KY.—The board of trustees of Kuttawa has ordered the sale of an electric light franchise for a term of twenty years.

HACKENSACK, N. J.—The Public Service Corporation has decided to reduce its charges for electric lighting throughout Bergen county.

OKLAHOMA, OKLA.—The contract for the installation of the electric lighting plant at Marietta, I. T., has just been let to Arnold & Weatherbee.

IRON RIVER, MICH.—The Iron River council has declared carried the proposition to bond the village for $20,000 for an electric light plant.

JACKSON, MICH.—The Grand Rapids-Muskegon Water Power Electric Company has turned on the current from its power dam No. 1 near Big Rapids.

RAYMOND, WASH.—A force of men is at work setting poles for the new electric light plant. The plant will supply lights for Raymond and South Bend.

NORTH BENNINGTON, VT.—It has been voted to adopt electricity as a lighting power, and to enter into a contract with the Bennington Electric Company.

PAINESVILLE, OHIO—The Commercial Electric Company has been sold to J. R. Curtiss, trustee, of Geneva. It will ask for a franchise to furnish lights for the city.

STANDISH, MICH.—The electric companies which are to erect large dams on the Rifle river are busy getting options on the land lying along the river for many miles on each side.

HOMER, LA.—The Homer town council has granted a franchise to Edward Saywer, of Ruston, to install an electric lighting system, the plant to be in operation within six months.

TUSCALOOSA, ALA.—The city council at a recent meeting granted a franchise to Robert Jemison and associates for water-works, electric light and gas plant and a street railway in the city of Tuscaloosa.

SOUTH FRAMINGHAM, MASS.—Milford, at its adjourned annual meeting, voted to contract for one year with the Milford Electric Light and Power Company for fifty-eight arc lights at $90 per light per year.

ELDORADO, KAS.—The Eldorado Light, Heat, Ice and Power Company, capitalized for $50,000, has been granted a franchise to build a gas and electric light plant in Eldorado, and has been given a contract for lighting the streets.

BAMBERG, S. C.—The board of public works has let the contract for the Bamberg electric light plant to the Electric Supply Company, of Savannah. The contract calls for a complete plant by August 1. There are to be thirty-one arc lights.

MENDOCINO, CAL.—The Stanley Electric Light and Power Company has secured a water right on Alder creek, near Point Arena, and will install a plant at once. The current is to be used to furnish Point Arena, Greenwood, Albion and Mendocino with light.

WEST CHESTER, PA.—The Edison Electric Illuminating Company has ordered a 500-horse-power engine and generator. These new machines will be installed during August next, and all other improvements completed, so that the plant will be increased fifty per cent in capacity before the busy season commences in the fall.

EMINENCE, KY.—The Eminence electric light plant, which was put in operation some two years ago, has been closed down. While the service has been excellent, the plant lost money. It is thought that another company will soon be granted a franchise to operate a plant in Eminence.

ALEXANDRIA, VA.—At a meeting of the city council the matter of the lease of the electric light franchise in Alexandria came up for discussion and both branches of council decided in favor of advertising for bids for the lease of the plant for a period of not more than thirty years.

SPOKANE, WASH.—The Inland Power and Electric Company has acquired 20,000 horse-power at Albany Falls, Idaho; 20,000 horse-power at Hell Gate in the Columbia river, and additional power at Metalline Falls on the Pend d'Oreille river in Stevens county. The company is incorporated for $1,000,000.

BELLOWS FALLS, VT.—The Fall Mountain Electric Light Company, the control of which is held largely by William A. Russell, of Lawrence, Mass., has bought the mill site at Gageville, a mile from Bellows Falls. It is understood the company will at once build a dam and install a power station.

FORT DODGE, IOWA—The Fort Dodge light and power plant has been sold to a company of investors from Grand Rapids, Mich., represented by the banking firm of Childs, Hulswit & Company, of Grand Rapids. The amount involved is over a quarter of a million dollars. The purchasers take immediate possession.

ALBANY, N. Y.—The Hudson River Electric Power Company will move nearly all its offices to Albany on May 1, and make that city the central point from which it will direct its several plants and transact the growing business acquired in the territory. The company now has its offices in Albany and Glens Falls.

LEBANON, PA.—The Hummelstown water plant, owned by a corporation capitalized at $45,000, and the Hummelstown electric light plant, owned by a corporation capitalized at $10,000, have been purchased by Allen K. Walton, of Hummelstown. Larger dynamos will be installed, and there will be other improvements.

RIVERSIDE, CAL.—A movement is on foot which contemplates the building of a $250,000 electric plant to supply power to the Santa Ana valley. Among those who are interested in the project are the Riverside Trust Company, the Riverside Water Company, the Riverside Land and Irrigation Company and the Chase Nursery Company.

VINCENNES, IND.—The annual meeting of the Vincennes Light and Power Company resulted in the election of this board: Edward M. Deane, Dwight Smith, Benjamin P. Merrick and Harry B. Wales, of Grand Rapids, Mich.; Henry Frund, J. W. Emison, J. L. Bayard, Jr., R. E. Purcell, W. H. Vollmer and Charles Bierhaus, of Vincennes.

PITTSBURG, PA.—To increase the revenue of the borough an addition to the Sharpsburg borough electric light plant is contemplated, council having authorized the erection of such an addition and the installation of more machinery. The present plant has a capacity of about 2,500 incandescent lights, and it is intended to increase this to 5,800 lights.

OGDENSBURG, N. Y.—Contracts have been awarded for the construction of a 1,100-horse-power plant in the St. Lawrence river canal around Duplatte Rapids by the village council at Morrisburg, Ont., to William Birmingham, of Ottawa, for $73,600. The village will supply the electric energy for a large tinplate plant that is being erected at Morrisburg.

FORT LAWN, S. C.—The Southern Power Company, of Fort Lawn, S. C., has ordered from the Westinghouse Electric and Manufacturing Company, eight 4,000-horse-power electric generators, twelve 2,500-horse-power, oil-insulated, water-cooled transformers, and auxiliary apparatus. This order is probably the largest ever given in the south for that class of material.

PHOENIX, B. C.—J. B. Henderson, who has been in charge of work on the substation for the West Kootenay Power and Light Company, has completed his task. The building has cost $20,000 and will contain about $20,000 worth of apparatus. At the Granby

smelter, Grand Forks, and the British Columbia Copper Company's smelter, Greenwood, exact duplicates of this substation will be built.

ROME, N. Y.—At the annual meeting of the stockholders of the Rome Electrical Company the following directors were elected: W. W. Parry, W. R. Huntington, T. G. Nock, N. H. Jones and G. A. Clyde. At a subsequent meeting of the directors the following officers were elected: president, N. H. Jones; vice-president, T. G. Nock; secretary and treasurer, G. A. Clyde.

RICHMOND, IND.—A syndicate of eastern capitalists has made an offer to purchase the Richmond municipal electric light plant, and has also agreed to pay $250,000 for it. In addition the syndicate agrees to bind itself by contract that it will not increase the rate for commercial lighting for a period of ten years, and also to make a less rate for street lighting than it now costs the city under the present arrangement.

IRON MOUNTAIN, MICH.—At a meeting of the board of directors, of the Iron Mountain Electric Light and Power Company, composed of O. C. Davidson, E. F. Brown, A. C. Cook, John T. Jones, James H. Cundy, George Irving, Jr., and L. T. Sterling, the following officers were elected to serve until the next regular meeting in July: President, A. C. Cook; vice-president, James H. Cundy; secretary and treasurer, L. T. Sterling; superintendent, George Irving, Jr.

WORCESTER, MASS.—The Worcester Light & Equipment Company, a new corporation formed to furnish light and power in Worcester under the H. H. Bigelow franchise, has been formed with a capital stock of $100,000, and its certificate of organization has been filed at the state house. Albert M. Thompson is president, William J. Hall, treasurer; Winslow H. Robinson, clerk, and William E. Lewis, Elmer E. Carpenter, Paul Potter and Henry Schoenfeld, of New York, are directors.

PITTSBURG, PA.—Men interested in the development of the towns along the Allegheny valley, including Tarentum, Brackenridge, Springdale, Arnold and other boroughs, are preparing to launch a light and power project which, it is believed, will be operated in connection with new traction lines now under construction from Pittsburg to Apollo and the Kiskiminetas and Upper Allegheny valley towns. Eventually the field of the power and light project will extend practically from Sharpsburg to Kittanning and Apollo.

ENGINEERING SOCIETIES.

PHILADELPHIA SECTION, AMERICAN ELECTROCHEMICAL SOCIETY—The Philadelphia (Pa.) section of the American Electrochemical Society held a meeting on the evening of April 6, at which abstracts from a number of recent electrochemical papers were read and discussed.

TORONTO BRANCH, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—On Friday, April 27, at the School of Practical Science, Toronto, Ontario, the Toronto branch of the American Institute of Electrical Engineers will hold its regular meeting. The institute paper, "Some Features Affecting the Parallel Operation of Synchronous Motor-Generator Sets," will be abstracted by Mr. W. A. Bucke.

BOSTON BRANCH, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The Boston branch of the American Institute of Electrical Engineers held its monthly meeting on April 11 at the Tech Union, Boston, Mass. The subject of the evening was "Submarine Signaling Apparatus," by Horace B. Gale. Mr. Gale gave a clear and interesting account of the installation of the apparatus, and cited as an instance where considerable loss might have been saved the ship Devonian, which went ashore near Boston a few weeks ago. If the ship had been equipped with this apparatus it would have had no trouble making port.

ST. LOUIS BRANCH, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The St. Louis (Mo.) branch of the American Institute of Electrical Engineers held a meeting on April 11 at the Engineers' Club, Mr. A. H. Timmerman presiding. The evening was taken up with a discussion of the rotary converter substation of the United Railways Company on Seventeenth and Locust streets, which was visited on the occasion of the last meeting. Following this Mr. J. H. Finney read a paper on "Bimetallic Wire," in which he described the new aluminum steel wire of the Pittsburg Reduction Company. After the meeting a buffet lunch, supplied through the courtesy of the Pittsburg Reduction Company, was served.

ELECTRIC RAILWAYS.

DES MOINES, IOWA.—The Des Moines, Winterset & Creston interurban has been granted franchises in Creston and Macksburg.

PONTIAC, MICH.—Farnum Brothers, of Pontiac, are promoting an electric line to connect St. Charles, Alma, St. Louis and Ithaca and then run south to Owosso.

WHITTIER, CAL.—At a city council meeting the city trustees granted a street railway franchise to S. W. Barton, agent for the Pacific Electric Railway Company.

NAPA, CAL.—The Napa city council has passed an ordinance granting a franchise to the Napa & Lakeport Railroad Company to operate an electric road on the streets.

TAMPA, FLA.—E. H. Kirkpatrick, of Johnson City, Tenn., has secured from the Tampa city council a franchise for an electric street railway on Florida avenue and La Fayette street.

CHICAGO, ILL.—The Chicago city council has granted the Northwestern Elevated the right to trolleyize the St. Paul tracks from its limits to Evanston. This will open up a big territory.

CLYDE, N. Y.—A franchise has been granted to the Rochester, Syracuse & Eastern Railroad Company to construct and operate an electric surface railroad through the roads and highways of Clyde.

ASBURY PARK, N. J.—The Neptune city council has passed the ordinance giving to the Atlantic Coast Electric Railway Company a franchise to operate on Main street of that borough for a term of forty years.

TEMPLE, TEX.—A movement is on foot to build a trolley line between Temple and Marlin, and the proposition has taken tangible shape. Money has been secured to make preliminary surveys and collect the required data.

LORAIN, OHIO—The Western Ohio Company has announced that it will build the missing link between Fostoria and Fremont, which will connect its main system with the Lake Shore Electric, completing a through trolley system from and to Cleveland.

ALBANY, N. Y.—The application of the Hudson Valley Railway Company for permission to increase its capital from $3,000,000 to $5,500,000, has been granted by the state board of railroad commissioners. The increase is to carry out projected improvements.

BOISE, IDA.—It is reported that a company has been organized to generate electric power from the Little Salmon and arrangements are being made to build an electric railroad from Meadows to Lardo, at the foot of Payette lake, the finest summer resort in southern Idaho.

LINCOLN, ILL.—The active work of track laying for the branch of the Illinois Traction system between Springfield and Lincoln will be commenced in April or May. The grading for the Springfield-Lincoln branch was completed some time ago, and the bridges have been constructed.

LAPORTE, IND.—Announcement is made that the company has been financed which will immediately begin the construction of a line of road between Rochester, Ind., and St. Joseph, Mich., thus completing another link in the system projected to unite Indianapolis with Grand Rapids.

HYATTSVILLE, MD.—Construction work on the Anacostia, Surrattsville & Brandywine Electric Railway has been begun on the District of Columbia section. It is thought that the road will be constructed and thoroughly equipped within nine months, all surveys and preliminary work having been completed.

ALBANY, N. Y.—The railroad commissioners have granted a certificate of necessity for the construction of a traction line, to the Geneva, Phelps & Newark Railway Company, connecting Geneva and Newark and passing through Phelps. The line, which will be fifteen miles in length, will be operated by power from Niagara falls.

ALAMEDA, CAL.—The Alameda city trustees have granted F. M. Greenwood a franchise to construct an electric traction system to be operated in connection with a ferry line to San Francisco. Under the terms of the franchise, which is for fifty years, Greenwood and his associates will have to commence work and complete the project

within two years. The grantee and his assigns are prevented from transferring their privileges to any common carrier now operating in Alameda.

DENVER, COLO.—At the annual meeting of the Denver City Tramway Company W. G. Evans was re-elected president, J. A. Beeler, vice president, and Thomas Keely, secretary and treasurer. Fred G. Moffat, Rodney Curtis, J. A. Beeler, W. G. Evans, S. M. Perry, Charles J. Hughes, Jr., S. F. Coulter and Thomas Keely were re-elected directors.

RACINE, WIS.—The town board of Caledonia has granted the application of Manager John I. Beggs, of the Milwaukee Electric Railway and Light Company, for an additional electric railway franchise through that township. The line will run from the subway north to the Milwaukee county line, three and one-half miles, making a direct line to Carrollville and Milwaukee.

GUTHRIE, OKLA.—For the operation of the Washita Valley Interurban electric railroad, Vice-President W. T. Croslen, of Shreveport, La., announces that water-power stations will be erected on the Pennington, Blue and Washita rivers, in the Chickasaw Indian nation. About 50,000 horse-power will be necessary for running the road and the various industries connected with it.

ST. LOUIS, MO.—A company has been formed for the construction of an interurban road from Decatur, Ill., to Mattoon and Sullivan, and work will begin in the spring, the surveys having been made. New York capitalists are negotiating for the building of another interurban line from Decatur east to Tuscola, a distance of about thirty-five miles. The estimated cost of the line is $1,200,000.

READING, PA.—The Ringing Rocks Electric Street Railway Company has changed its name to the Pottstown & Northern Railway Company. The officers elected were: Dr. W. B. Shaner, president; Ralph E. Shaner, secretary; H. M. Boone, treasurer, and Dr. J. F. Mentzer, of Ephrata; A. K. Shaner, Thomas Searles, H. M. Boone, Ralph E. Shaner, of Pottstown, and Cyrus Q. Guldin, of Reading, directors.

MONTREAL, QUEBEC.—The Longueuil Electric Railway Company will immediately begin to construct lines in various sections of the county of Chambly as the result of a decision of the Longueuil town council granting it a thirty-year franchise. The electric railway will reach Montreal by way of Victoria bridge, and on the city side connections will be made with the Montreal street railway. This line is expected to be in operation before autumn.

DEFIANCE, OHIO.—It is stated that the Schoepf syndicate still holds an option on the Columbus & Lake Michigan railroad, which runs between Lima and Defiance. The intention is to convert the railroad into an electric line for passenger service, extend it north to Bryan to connect with the Toledo & Indiana, and south of Lima to connect with an interurban line into Columbus. This would give a direct route from Toledo to Columbus and Cincinnati.

UPPER SANDUSKY, OHIO.—The connecting link between Cincinnati and Toledo will be constructed this summer, as the proposed electric railway from Marion to Findlay will make the line complete. The company to build the line has been organized, and the president, R. P. Hankey, of Detroit, and the secretary, G. W. Meeker, of Columbus, with other members of the company, have completed arrangements for the construction. The line will pass through Forest and Marseilles.

BINGHAMTON, N. Y.—The Waverly, Sayre & Athens Traction Company has been bought by G. T. Rogers, of Binghamton, and Joseph A. Powers, of Troy, N. Y. These parties are also interested in the Elmira, Corning & Waverly Railroad, to which a certificate was recently granted by the railroad commissioners. It is understood that the Waverly road will be extended south to Towanda, and the Binghamton railway, of which Mr. Rogers is president, is now being extended to Oswego.

GADSDEN, ALA.—Incorporation papers have been filed by the Gadsden Railway, Light and Power Company, the stockholders of which are George H. Schuler, E. T. Schuler and O. R. Hood. This is a subsidiary company of the Alabama City, Gadsden & Attalla Railroad Company, and is formed for the purpose of carrying out extensions and improvements in the present street railway and city lighting facilities. The proposed new street railway line will have for its terminals Attalla and Gadsden.

HOUSTON, TEX.—Actual work upon the La Porte branch of the Houston-Galveston interurban has been commenced at La Porte. Officers of the company state that the work will be prosecuted diligently and that the interurban for Houston and Galveston is a certainty. The following are those at the head of the enterprise: President, J. O. Ross; vice-president, H. C. House; secretary, F. L. Dana; treasurer, J. S. Rice; general attorney, O. T. Hold; land commissioners, W. E. Scott, Hyman Levy, E. C. Barrett and W. J. Moore.

MARTINEZ, CAL.—Following the filing of articles of incorporation in San Francisco by the Martinez & Contra Costa railroad it is reported that it is the intention of the incorporators to build an electric road from Martinez to Antioch, Byron Springs and through the San Ramon valley to connect with the Key route in Berkeley. The Martinez & Contra Costa railroad has a capital stock of $100,000, of which $5,000 has been subscribed by the following directors: Purcell Rowe, M. R. Jones, A. H. Flynn, W. A. Tolchard and Carl A. Johnson.

SAN FRANCISCO, CAL.—The Central California Traction Company, which has just built nine miles of electric road in Stockton, is to immediately build a line eighteen miles long between the latter city and the town of Lodi. The directors and large stockholders of the company consist of Mortimer Fleishhacker, Alden Anderson, H. Fleishhacker, H. H. Ferns, F. W. Smith, H. H. Griffiths, W. J. Bartnett, J. Dalzell Brown, John Treadwell, Fred M. West and David M. Walker. At a recent meeting it was decided to issue $1,500,000 worth of bonds. The latter will be sold, and the proceeds used for extensions, including the Lodi line.

CUMBERLAND, MD.—The charter rights and franchises of the Somerset County Street Railroad Company have been sold to a syndicate headed by Charles H. Jennings, of Jennings, Garrett county, Md., who a few weeks ago secured a franchise of the streets of Salisbury and Meyersdale for a proposed electric line between Frostburg, Md., and Johnstown, Pa., to connect at Frostburg with the system running between the latter point and Cumberland. The Somerset concern took out a charter two weeks ago for a proposed line from Paint Creek to Rockwood, paralleling the Somerset and Cambria branch of the Baltimore & Ohio Railroad. Geo. R. Scull and William H. Ruppel, of Somerset, retain an interest in the syndicate.

BALTIMORE, MD.—Mr. George T. Bishop, who is directing the affairs of the Washington, Baltimore & Annapolis Electric Railway Company, announces that the contract for grading, ballasting and the track laying of this line has been awarded to the Fidelity Construction Company, of Detroit. The work will include only that portion of the line from the city limits of Baltimore to the boundary line of the District of Columbia. The work in this territory will begin as soon as the weather permits, and it is to be completed in twelve months. The road is to be a trolley line to connect Baltimore and Washington. On completion a thirty-minute schedule will be maintained between the two cities. The company now possesses all the privileges it needs in the intervening territory between the two cities, having secured all the desired rights of way in the counties through which it passes. It also has an entrance into Washington, and has made satisfactory arrangements with the United Railways system to reach its terminal station in Baltimore, conditional upon the sanction of the city council.

NEW MANUFACTURING AND CONSTRUCTING COMPANIES.

COLUMBUS, OHIO—The United States Electric Porcelain Company, of Findlay, has been incorporated with a capital of $25,000.

ALBANY, N. Y.—The Associated Gas and Electric Company, Penn Yan, has been incorporated to manufacture engines, boilers, dynamos, motors, gas apparatus, etc., with a capital of $1,500,000. The incorporators are Ebezer M. Treman, Thomas W. Summers and William T. Morris, all of Ithaca, N. Y.

SAN JOSE, CAL.—Articles of incorporation of the Blake Brothers Electrical and Fixture Company have been filed with the county clerk. The company is formed for the manufacture and sale of electrical supplies. Its principal place of business is San Jose. The amount of the capital stock is $25,000. Of this $7,000 is subscribed by the incorporators, F. T. Blake, John H. Blake, John Frank, T. E. Baker and L. E. Baker.

PERSONAL MENTION.

MR. JOSEPH C. FRANCE has been elected general counsel of the United Railways and Electric Company, Baltimore, Md.

MR. ROBERT M. LEWIS has been appointed manager of the Southern Bell Telephone and Telegraph Company's exchange at Anderson, S. C. Mr. Lewis has been with the Bell company for a number of years, holding different positions.

MR. JULIUS C. CALISCH, who for several years has been manager of the Buffalo (N. Y.) branch of the General Electric Company, has been selected as general manager of the new company which is to create an electrical system between Buffalo, N. Y., and Erie, Pa.

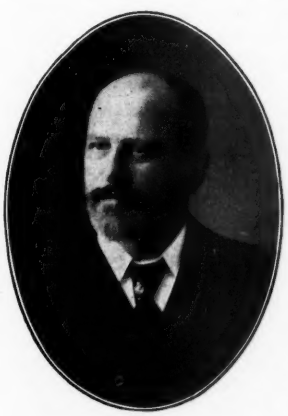
MR. FREDERICK A. J. DUNWICK has been appointed the manager of the Pulaski (N. Y.) exchange of the Black River Independent Telephone Company. It is expected that a direct line between Pulaski and Syracuse will soon be built by the Black River company.

MR. T. M. MESTON, second vice-president of the Emerson Electric Manufacturing Company, St. Louis, Mo., was a visitor to New York this week. Mr. Meston is one of the enterprising electrical men of the West, and is looking after some of the company's extensive eastern interests.

MR. H. B. WALES, manager of the Salisbury-Spencer (N. C.) Electric Railway and Light Company, has resigned. Mr. Wales has been doing some remarkable work in improving the efficiency of the street car lines in Salisbury, and will now assume charge of a number of plants affording him larger possibilities. He will be succeeded by Mr. James A. Trimble, of Grand Rapids, Mich.

MR. FRANK H. TAYLOR has severed his connection with the Westinghouse interests, of which he has been for the past eight years one of the most prominent officials, especially as the vice-president of the Westinghouse Electric and Manufacturing Company in charge of commercial operations. It is understood that he proposes to enjoy a well-earned rest after his extremely active life of recent years before taking up any new line of work. His many friends will wish him a thoroughly enjoyable vacation and welcome his return to active business.

MR. ADELBERT O. BENECKE, chief engineer of the American Instrument Company, Newark, N. J., was born July 31, 1855, in Elbing, Germany. After graduating from the college at Elbing he entered the University of Koenigsberg, Prussia, where he studied mathematics and natural philosophy from 1876 to 1879. During this period he was an assistant in the physical laboratory, under Professor W. Voight, and assisted Professor Luther in the astronomical observatory. He also served an apprenticeship in a shop where instruments of precision were manufactured. At the University of Berlin, under Helmholtz, Kirchhoff, Weierstrass, Kummer and others he continued his studies from 1879 to 1881. He then undertook the manufacture of scientific instruments in Berlin. His combination of theoretical knowledge and mechanical ability made his service eagerly sought for in Germany at that time, and his advice was also sought by many scientists interested in research work for which special apparatus was required. Coming to the United States in 1889 he became associated with the Weston Electrical Instrument Company at Newark, N. J., remaining for fourteen years as chief electrician and assistant to Dr. Edward Weston. He was in charge of the laboratories and the designing and experimental work of the company, and participated in the research work carried on by Dr. Weston. He also acted as expert in numerous patent suits. Several inventions relating to electrical measuring instruments and kindred objects have been patented by Mr. Benecke. From July, 1904, to April, 1905, he traveled through Europe for the purpose of studying physical and electrical laboratory methods and equipments. Mr. Benecke is a member of the American Institute of Electrical Engineers.



MR. ADELBERT O. BENECKE.

ELECTRICAL SECURITIES.

Hope for a spring bull movement is based largely on expectations of a gradual easing of money rates. The great demand for money from the interior, the bank deficit of the previous week, and the scarcity of gold importations, produced a high money market which, during the first half of the week, made the rates for loans almost prohibitive. The plan outlined by Secretary Shaw went a long way toward bringing about monetary ease, and at the close of the week rates had dropped to a new low point, and a substantial surplus had taken the place of the deficit at the beginning of the week. Speculative interest in the coal labor situation has steadily diminished, and even the practical suspension of negotiations between the anthracite operators and the miners has had only a weak market reflection. General trade prosperity shows no signs of abatement. The reports from most of the important railroads show good gains, and overcome any adverse influence which might have been expected from the poor showing of the Big Four system and the Long Island Railroad.

ELECTRICAL SECURITIES FOR THE WEEK ENDING APRIL 14.

New York:	*Closing.*
Allis-Chalmers common	21
Allis-Chalmers preferred	56½
Brooklyn Rapid Transit	87⅞
Consolidated Gas	139½
General Electric	171
Interborough Rapid Transit	230
Kings County Electric	165
Mackay Companies (Postal Telegraph and Cables) common	64¾
Mackay Companies (Postal Telegraph and Cables) preferred	73¼
Manhattan Elevated	153
Metropolitan Street Railway	116
New York & New Jersey Telephone	147
Western Union	92¼
Westinghouse Manufacturing Company	160

The records for the first three months of business in 1906 ending March 31 show a large increase over the same period of last year in all the Westinghouse companies. The business at the electric works in East Pittsburg has never before equalled the present reports.

A special meeting of the Interborough-Metropolitan Company's stockholders will be held April 27 at 12 o'clock, noon, for the purpose of voting upon a proposition to alter the certificate of incorporation of the company.

Boston:	*Closing.*
American Telephone and Telegraph	138¼
Edison Electric Illuminating	247
Massachusetts Electric	66
New England Telephone	140
Western Telephone and Telegraph preferred	89

Directors of the New England Telephone and Telegraph Company have declared the regular quarterly dividend of 1½ per cent, payable May 15 to stock of record April 24. Transfer books close from April 25 to May 7. The company will hold a special meeting May 7 to authorize an increase in capital stock from $30,000,000 to $50,000,000.

Philadelphia:	*Closing.*
Electric Company of America	11¾
Electric Storage Battery common	78
Electric Storage Battery preferred	78
Philadelphia Electric	8⅛
Philadelphia Rapid Transit	28½
United Gas Improvement	94¾

The annual report of the Philadelphia Electric Company for the year ended December 31, 1905, is as follows: gross, all sources, $4,164,113; operating expenses, taxes and fixed charges, $3,353,097; surplus, $811,016; dividends, $499,935, leaving a balance of $311,081, as compared with $300,522 for the previous year. The previous surplus was $1,100,656, making the total surplus $1,411,737. The stockholders of the company have reelected the old board of directors.

Chicago:	*Closing.*
Chicago Telephone	113
Chicago Edison Light	156
Metropolitan Elevated preferred	68
National Carbon common	91
National Carbon preferred	116
Union Traction common	7
Union Traction preferred	21

Chicago Edison Company's directors have declared the regular quarterly 2 per cent dividend, payable May 1. Books close April 23 and reopen May 2.

INDUSTRIAL ITEMS.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is calling attention to the "O. K." weatherproof wire, and also to Packard lamps, for which specialties it is the general western agent.

THE WESCO SUPPLY COMPANY, Seventh street and Clark avenue, St. Louis, Mo., is calling attention to its porcelain specialties. A special price card is being sent to the trade.

THE STANLEY-G. I. ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has removed from its New York office to larger quarters at No. 42 Broadway. The telephone numbers are 3731, 3732 and 3733 Broad.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., is distributing a neat booklet entitled "Where Neatness Counts as Against Any Old Thing." This calls especial attention to attachment plugs and standard sockets. The company has also issued price list No. 6, descriptive of Paiste electrical specialties.

THE L. B. ALLEN COMPANY, INCORPORATED, Chicago, Ill., has ready for distribution a series of jobbers' price lists, which will be sent to jobbers writing on their own letterheads. These lists give special prices on the Allen soldering specialties.

MR. N. D. MACDONALD, of the Electrical Testing Laboratories, New York, is dividing his time this month between the Locke Insulator Works, Victor, N. Y., and the Thomas Insulator Works, Lisbon, Ohio, inspecting and testing high-tension insulators for several transmission plants in the West.

THE NEW YORK TELEPHONE COMPANY, New York city, is distributing its very attractive calendar, which shows three months at a glance. This gives the preceding month, the present month, and the month following. Upon each calendar pad there is a suggestion concerning the advantages of the telephone.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., in the April issue of "Graphite," publishes an analysis of a test made by Professor Goss, of Purdue University, demonstrating the value of Dixon's flake graphite as a lubricant, and its mechanical affinity for metallic surfaces.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has published a bulletin entitled "Spring Painting." This company's graphite paints are used in very large quantities for structural painting of every character. It is announced that as a paint pigment this flake graphite has remarkable preservative and wearing qualities.

THE MECHANICAL RUBBER COMPANY, Cleveland, Ohio, has recently published a very handsome catalogue descriptive of the "Marco" packings, manufactured at the company's Cleveland rubber works. The illustrations in this catalogue are made directly from the raw product, and are shown just as the material appears, without retouching or reengraving.

M. W. DUNTON & COMPANY, Providence, R. I., announce the establishment of a New York office for the sale of "Nokorode," with William Timanus McDowell, 51 Liberty street, where a full stock of "Nokorode" in all sizes of boxes will be carried. New York customers will in this way secure quicker deliveries and at the same time save transportation expenses.

G. M. GEST, the expert subway contractor, New York and Cincinnati, has obtained control of the Rundle patented graphic chart system for recording underground and overhead cable data. This system of charts has been adopted by the largest conduit users in the United States. Further data concerning this cable chart and its uses can be secured by making application at any of G. M. Gest's offices.

E. B. LATHAM & COMPANY, New York city, announce their removal to 4 Murray street, corner Broadway, where the entire building of seven floors has been leased. The added space will enable them to serve their customers more promptly than heretofore, and the stock will be more than doubled. A complete line of electric light, railway, telephone, telegraph, automobile and house goods supplies will be carried.

THE ELECTRIC CABLE COMPANY, Bridgeport, Ct., will have its new factory completed the latter part of April. A reception will be given on the date of its completion to the members of the Bridgeport board of trade, to the employés of the company and to the engineers and workmen who were at work on the building. The plant will be devoted to the manufacture of "Voltax," the new insulating compound made by this company.

THE STANDARD CHEMICAL COMPANY, Cincinnati, Ohio, is placing on the market its "Imperial" flux in stick form. The "Imperial" soldering paste manufactured by this company has been well received and is in constant use all over the country. The company expects that "Imperial" flux in stick form will be as well received and will meet the demand which has been experienced for the flux in this shape.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., announces that its erecting department for Manhattan borough, which until recently was located on the nineteenth floor of the Trinity Building, has been moved to the Fuller Building, corner Twenty-third street and Broadway, New York city. More space was needed for the department, and the uptown location is more suitable and convenient for the construction work.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has completely outgrown its present quarters and has bought a tract of land fifteen acres in extent just outside of the city. Messrs. Dodge & Day, Philadelphia, Pa., have been engaged to lay out the plant, design the buildings and select the necessary equipment. The preliminary layouts have been submitted, and the buildings decided upon. Work will be started at once and about one-third of the ground will be covered by buildings before the end of the present year.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has ready for distribution a new series of literature, including flier No. 2176, descriptive and illustrative of universal sockets, shades and portables; flier No. 2177, multiplex lightning arresters, shunt resistance, multigap type. The General Electric fan motor catalogue for 1906 is printed in very handsome style, the cover being particularly good. Bulletin No. 4434 describes the "G. E. M." high-efficiency, high-candle-power incandescent units; bulletin No. 4436, direct and alternating-current automatic carbon break circuit-breakers, type C, form G; bulletin No. 4437, General Electric straight air-brake equipments.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, through its Philadelphia (Pa.) branch, has recently completed two of the season's largest contracts for the installation of its various pipe coverings in the plants of the Marlborough-Blenheim and the Denis hotels, at Atlantic City, N. J. In the plant of the former all of the hot, salt and fresh-water pipes are covered with the "J-M" moulded, and all steam pipes with the "J-M" eighty-five per cent magnesia covering. In the Denis the entire heating system is covered with "J-M" three-ply asbestos air-cell covering, and the high-pressure work with eighty-five per cent magnesia. These coverings are only a few of the many standard coverings manufactured by this company. A neat and attractive booklet has recently been issued entitled "Pipe and Boiler Insulation." This book will be sent to interested parties upon request.

LEGAL NOTES.

$500,000 SUIT FOR BUSINESS DAMAGES—Mr. George Campbell, president of the Germania Lamp Company, has instituted suit in the United States Circuit Court, Southern District of New York, against the Edison Electric Light Company, alleging business damages to the extent of $500,000. The plaintiff says that in consequence of suits against him by the defendant company for alleged infringement of United States patent No. 444,530, and in consequence of the actions of the servants of the defendant corporation, he was financially ruined.

WIRELESS TELEGRAPH LITIGATION—In the United States Circuit Court for the Southern District of New York, in the suit of the National Electric Signaling Company versus the De Forest Wireless Telegraph Company, *et al.*, an opinion has been handed down by Judge Wheeler, reaffirming his original decision in the litigation between these two companies. He holds that certain modified forms of the Fessenden liquid barreter, made, used and sold by the defendants, are an infringement of the patent and a violation of the injunction that had been granted against the defendants in that suit.